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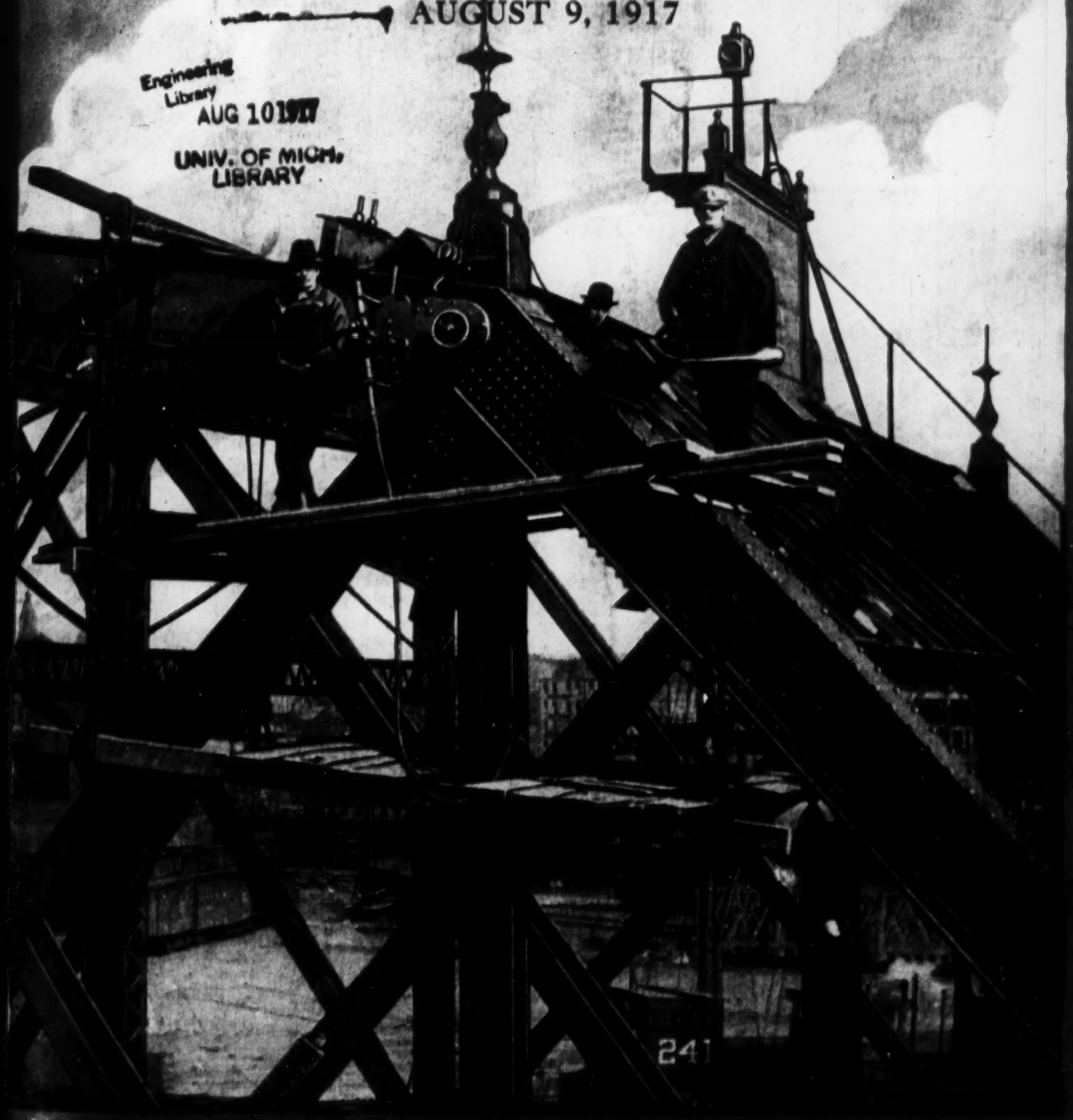
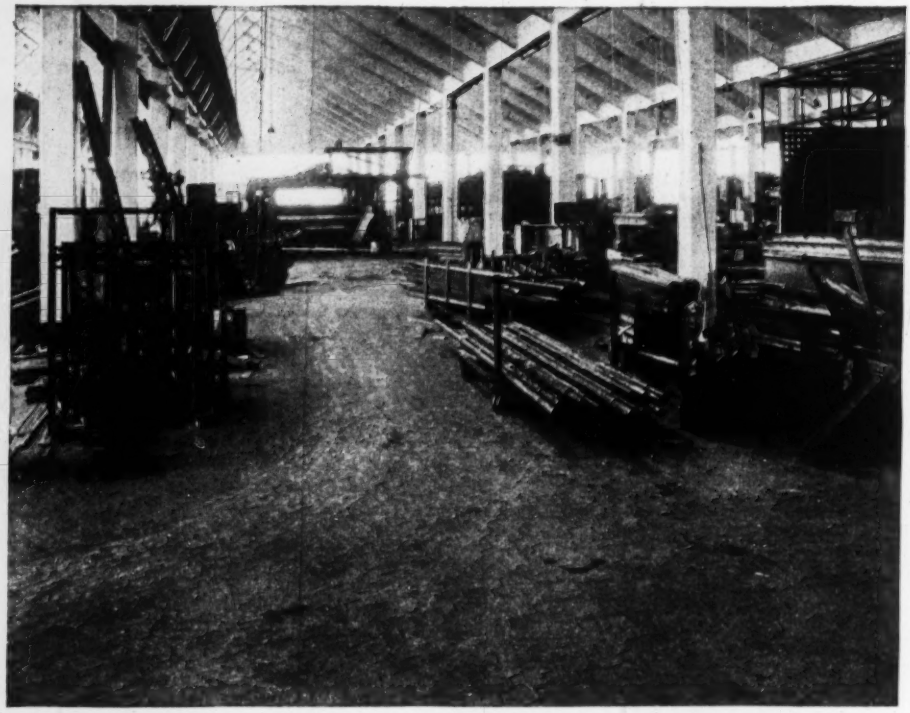


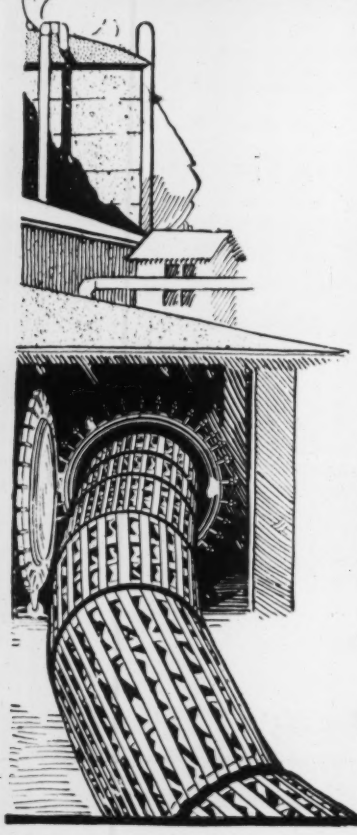
Loose Pin Joints of Harlem River Bridge Repaired by Original Method

Cover released by courtesy of Ehret Magnesia Mfg. Co., Valley Forge, Pa.

Kreolite Wood Block Floors
"They outlast the factory"



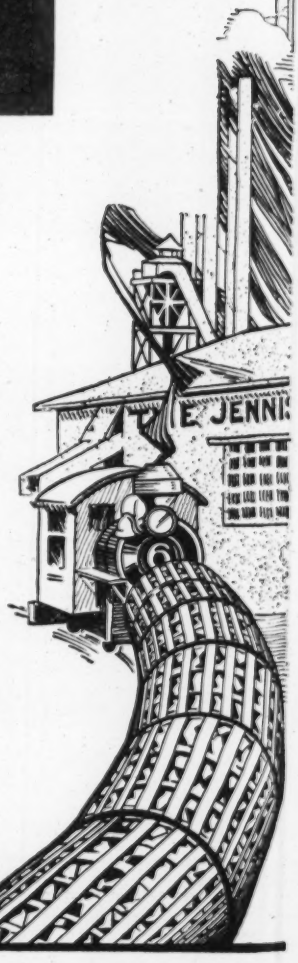
Kreolite Hex Wood Block Floor in the plant of the Philadelphia Textile Machinery Company.



"It Stands Up to the Work Wonderfully and Our Workmen Like It"

This is only one of the many rooms where Hex Wood Block Flooring is used by this company. Note the hard wear this floor receives from the heavily loaded trucks, yet the tractive resistance of this floor is so low that heavy loads are easily handled. This is what Mr. Walter M. Schwartz, President of the Philadelphia Textile Machinery Co., has to say of Kreolite Hex Block Floors:

"We take this opportunity to inform you of our satisfaction with the Hex Wood Block Floor. The buildings that we put up were under contemplation for several years before we actually went ahead with them, and during this period we investigated and examined practically all different kinds of floors. We now feel that our decision in favor of your Hex Wood Block Floor was well founded, and were we to do the work over again we should certainly put this kind of floor in. It stands up to the work wonderfully, and our workmen like it."



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AND CONTRACTING

Volume 79 NEW YORK, THURSDAY, AUGUST 9, 1917 Number 6

Joint Effort Produces Great Results

WORKING shoulder to shoulder is the essence of our national spirit just now. Only the immense sweep of this spirit through the country could accomplish what has been accomplished. We are learning new things in efficiency. Records are being made under hastily organized coöperation that surpass the best ever done through single effort—as witness the years of doing that have been crowded into four months in the Government's own work. But as fine a record as any is that which the Railroad's War Board can show. The traffic performance of the country's railroads has increased everywhere: in degree of loading, in daily mileage per car and per engine, in traffic moved daily per engine and per car. If these are the results of coöperation in wartime, may we look to reaping similar advantage from peace-time cöoperation?

Technical Men Get No Apology

SOME weeks have passed since two or three senators attacked the reputation of technical men engaged in helping the military authorities in their present rush work. The patent injustice of the attack surely became evident to the senators soon after, as the facts were so clear that they could not be mistaken—but there has been no apology to the men whose work and motives were wronged. Simple justice calls for such apology. The senators said, while speaking of civilians elevated to high military rank while still performing civilian duties, that this list constituted a burning scandal, "that many of the men did not know enough of military tactics to drill ten men without getting them all tangled up in their feet." Most of the civilians in question are men who have been appointed majors, and most of them are engineers and have been urgently needed by the Government in rushing its great building program forward. They undertook the work at a personal sacrifice. Their $3000 stipend as major is far less than their professional income. No better evidence of their efficiency could be asked than the powerful progress which is being recorded by the cantonments, with whose construction most of the majors in question are connected. These men were not commissioned for the purpose of maneuvering troops, and the gibe at their alleged ignorance of military tactics is, to say the least, pointless. If the Government is really paying these men more than their services are worth, the senators should by now have followed up their idle accusations and cleaned those civilians out of office. The only alternative is that they apologize for their unjustified attack.

Portable Saws and Army Camps

THE wonderful speed being made in the construction of wooden buildings for army camps is due in no small degree to the portable sawmill, the development of which has been largely brought about through the growth of reinforced-concrete construction. Contractors engaged on concrete building work soon discovered that these little power-driven saws were most effective labor savers in form construction. Big reinforced-concrete structures often require the framing of more than a million feet of lumber, which can be done far more quickly and cheaply by one or two of these little mills than by hand. This development has paved the way for the quick execution, in the face of a severe labor shortage, of the greatest frame building operations ever undertaken—the encampments for regular land and naval forces, and the sixteen cantonments for the National Army. At each of these locations batteries of these busy little saws are framing daily half a million feet or more of lumber so accurately that the pieces go together without further fitting like a set of children's building blocks. The contractors and manufacturers who developed this useful tool deserve the thanks of the country.

Waterways Commissioners Should Be Engineers

THE long advocated Waterways Commission is practically assured by the agreement in conference of both houses of Congress to include it in the current Rivers and Harbors bill. There are many who could wish for a stronger organization than is assured by the bill, for the law gives only the vaguest powers to the commission. Its functions are purely investigatory and its duties embraced by instruction to "formulate and report to Congress a comprehensive plan or plans for the development of waterways and the water resources of the United States for the purposes of navigation and for every useful purpose." The control, then, of the many interwoven activities relating to the uses and abuses of water will remain in its present divided state

awaiting the further action of Congress in response to the commission's investigation. That any commission at all was appointed, however, is one very definite step toward a rational administration of the diverse elements that go to make up what are called the water resources of the country. Whether such a preliminary step toward a rational administration of the diverse sonnel of the commission, for an entirely inadequate amount of money has been appropriated for its expenses and its organization. The President will have the appointment of the seven members, at least one of whom must be an army engineer and one an expert hydraulic engineer from civil life. The remaining five may each be selected either from civil life or the public service. A salary sufficiently attractive to politicians has been provided, but the job is so essentially of an engineering nature that the President should surely see to it that a larger representation of engineers is made. Is there not here a chance for engineering organizations to practice some of the recent publicity preachments and to try to get through the barriers now surrounding the White House a proper appreciation of the need of engineers on this commission?

Structural Engineers Need To Assert Themselves

ECONOMIC design of industrial buildings such as mills and factories is a matter for the trained engineer, to insure that the structures combine strength and economy. Especially is this the case where heavy loading or the stresses due to operation of machinery are factors in the design. This seems obvious enough. But it is not recognized as generally as it should be by those who order the construction of buildings of this class. Sometimes this is due to a direct desire to save the expense of expert engineering advice, under the mistaken impression that such expense is not really necessary. More often it is due to a failure to comprehend the functions of engineering and the engineer in relation to building design. And this condition results in large part from failure of the engineer or the engineering profession to properly assert or give publicity to these functions.

An engineer specializing in the design of large industrial buildings stated recently that in many cases he finds the owner has no conception of the function of an engineer in the design of buildings. Thus, a man intending to establish a factory or industrial plant will give first consideration to the machinery and equipment, and regard the building merely as some sort of shelter to house the plant. Then he is likely to place the contract for the machinery as the first and most important step. It happens not infrequently that the machinery firm will then undertake to furnish him plans for the buildings "free of charge." Of course, he has to pay for them indirectly, and it is surprising that a hard-headed business man does not see this. If they are uneconomical or defective, he may have to pay for subsequent alterations or reinforcement.

The engineer noted above states that in investigating buildings designed in this way he has found girders of excessive strength as compared with the floor slabs, and columns of insufficient strength for such loads as could be carried easily by the girders. In one case where plain footings were planned, the owner fortunately conceived some distrust and called in an engineer. The latter not only found it absolutely necessary to provide heavy pile foundations to carry the load, but was able to improve the structural design greatly.

A lesson to be drawn from this situation is that it is highly desirable for the engineer and the engineering profession to do more than has been done in the way of educating investors, proprietors, manufacturers and others as to the real need and value of engineering advice and skill in the design of buildings as well as in that of the machinery or plant which the buildings are to contain. One way is for the engineer to become an active member in the local Association of Commerce and thus establish personal relations with men in commercial and industrial lines. These men would as a result learn the scope and importance of engineering, and at the same time the engineer would broaden his own views as to the commercial aspects of engineering work.

One Commission Sees Through Two Common Valuation Fallacies

BECAUSE of the illiberal attitude shown by the state utility commissions in the proceedings before the Interstate Commerce Commission relative to the valuation of the railroads, and in valuation matters generally, *Engineering News-Record* is glad to be able to commend certain findings of one state commission. The case in point is a recent decision of the Maine Public Utilities Commission concerning the Biddeford & Saco Water Co. There are parts in the decision with which we disagree, but two points in the decision stand out.

One of these is that the cost of service pipes charged against earnings should be allowed in the valuation. The finding is definite and concise. "We think," says the commission, "that it makes no difference that the cost of the services represented by this sum had been charged off; nor, under the circumstances of this case, that the payment for them came from water revenues. The water company has installed the services; they remain its property, used and useful, and they were paid for from moneys otherwise available for division among the stockholders, received from rates then legally in force, and not shown to have been excessive, and before the present accounting regulations required such charges to be capitalized. Neither law nor equity requires this claim to be disallowed."

The other point is that depreciation in a rate case

may be less than for a sale. The argument is that "so long as the utility is giving efficient service, the public is interested only that it be able to renew parts when they cease to be efficient, and the utility is impressed with the duty to make such renewals. There is devoted to the public service a present plant, its life partially gone but still efficient, plus the owner's obligation to maintain the efficiency by renewal of parts. This renewal will be at his own expense, from income otherwise available for dividends, because the future depreciation load in the rates should be sufficient only to care for current depreciation."

On both of these points the Maine commission's views are absolutely at variance with the attitude of the state commissions at the Federal hearings on the railroad valuations. Even Director Prouty, of the Division of Valuation, contended at a recent hearing that to allow value on plant paid for out of earnings is to charge the public twice for the same thing. The Maine commission perceives what the state commissions generally do not see, that the stockholders, by reduced dividends, pay for all they get, without any deductions from value. If they pay for plant out of earnings, they go without money otherwise available for dividends. If they fail to provide depreciation funds, they ultimately make up the deficit by going without money otherwise available for dividends. The adjustment in either case is automatic, and the Maine commission is to be commended for perceiving this fact.

Hard Roads, Marketable Produce

AS NEVER before, hard-surfaced roads are going to mean prosperity to the farmer. No small part of the great American problem of feeding the rest of the world rests on the serviceability of our country highways. The difference between mud roads and hard-surfaced roads will be the difference between crops rotting on the ground and in farmers' cellars and crops on the way to the world's markets.

Never before have the railroads been so tied up with the transportation of industrial products. The building of the many army cantonments and the immense shipments of lumber and other construction material required for them is but one item in the transportation business which the establishment of these cantonments will bring about.

The time is soon at hand when immense crops, greater than ever in the history of the country, must be moved. Railroad men in the industrial centers of Pennsylvania and Ohio are stating that they themselves do not believe the railroads, by fall of this year, will be able to handle anything like the business which will be expected of them. For several years they have pleaded poverty and lack of adequate terminal, track and equipment facilities, so that today in the agricultural sections of the country the railways are little, if any, better prepared to handle business than they were during the depression period of four or five years ago.

An officer of a large railway company operating in Western Pennsylvania has stated that by fall the company will not be able to take shipments for distances of less than forty miles. The difficulties experienced already by contractors all through the East in obtaining cars for moving their plants and in getting shipments of materials of any kind whatsoever are too well known to need repetition. These same conditions may be expected by the farmers when they are ready to ship the enormous crops which have been planted.

The contractors have met the situation in many instances by using great fleets of motor trucks, and in many large industrial cities in the East they have ceased altogether to depend upon the railroads for gravel and broken stone supplies. Gravel and stone plants which are so far from cities as to be dependent upon the railroads for moving their output have been obliged to close down because it is impossible to operate them so intermittently as cars can be secured.

It was pointed out in *Engineering News-Record* a few weeks ago how a number of manufacturing concerns have adopted motor trucks for long-distance haulage, even so far as from Akron, Ohio, to Boston, Mass. The solution of the problem of moving the farmers' crops distances of forty miles or less is inevitably going to fall upon motor trucks and teams. The prospects are that motor-truck owners in the cities will find a legitimate and constantly increasing business in moving farm products, just as today they are engaged in moving every other kind of freight between cities.

This can be done and is now done only where there are hard paved interurban roads. Fortunate, therefore, is the agricultural community which is connected with the great industrial and railway centers by paved roads. Highway engineers throughout the East have fully appreciated this and reports from them made to this journal early in June emphasized the necessity of continuing road building. The Ohio Highway Department has steadfastly stood out for an extensive road-building program even against opposition from Washington, and in the face of discouraging conditions.

The wisdom of this move is already being felt in Ohio, and it will be in every agricultural state. It is not so much a question of whether the roads can be built as cheaply and efficiently today as they were yesterday, but it is a question of whether the crops which the farmers have been induced to plant are going to be used or are going to rot.

If the pinch of railroad congestion has been felt by such shippers as the great industrial concerns, how much more will it be felt by the lone farmer. If motor trucks have helped solve the problem for the manufacturer, merchant and the contractor, how much more will they help solve the problem for the farmer, *provided* the farmer has the roads to utilize trucks. More than ever before will the farmer appreciate good roads if he has them, or lament their absence if he has them not.

Worn Pin Bearings of Railway Bridge Repaired Under Traffic

Bad Wear at Pins in New York Central's Most Important Bridge—Rig for Boring Chord Webs Around Pin Is Used Successfully—Steel Bushings Pressed In

By H. T. WELTY
Engineer of Structures, New York Central Railroad, New York City

SERIOUS wear at the pins of the New York Central's Harlem River bridge—one of the most important bridges on the system—led to a difficult repair job, completed a month ago. The pins had worn the holes in the chord webs oblong to the extent of allowing very noticeable motion under a passing train. No precedent for repairing such a condition could be found. Entirely original method and tools were devised. The chord webs were bored out around the pins, without removing the pins and without stopping traffic on either bridge or river. Then tight-fitting steel bushings were pressed in. The joints are now in as good condition as when the bridge was built.

The four-track Harlem River bridge, commanding the railway's only line of access to Grand Central Terminal, New York City, carries some 700 train or engine movements per day. It was built in 1895 and consists of a swingspan and two fixed spans, each having three lines of trusses supporting steel trough flooring. Types and span lengths are shown by an accompanying sketch.

The bottom chords of the trusses, continuous from end to end of each truss, are composed of two angle-and-plate segments with their top flanges connected by double lacing bars. They vary in depth from 36 in. to 48 in. The trough floors are suspended from these chords by riveted angle connections and are continuous under the center trusses. The tension diagonals consist of eye-bars. Practically all joints throughout the trusses are made by pins, of diameter from 5 in. to 10 inches.

Remarkable Wear at the Pins

Due to the alternating positive and negative bending of the bottom chords under load, caused by the solid floors and the continuity of the chords, and to reversal of stress in the web members, there has been a constant wear on the pin bearings in these chords. On account of the great number of train movements this wear finally reached the point where repairs were imperative.

Careful measurements were made throughout the structure to determine the exact amount of wear at each pin bearing, the location of the wear in the chord webs relative to the pins, and to note the bars which were slack due to wear at the pin bearings. The accuracy of these measurements was facilitated by templets which were made of each bearing by fitting pieces of heavy paper over the ends of the pins, hammering the paper lightly against the chords.

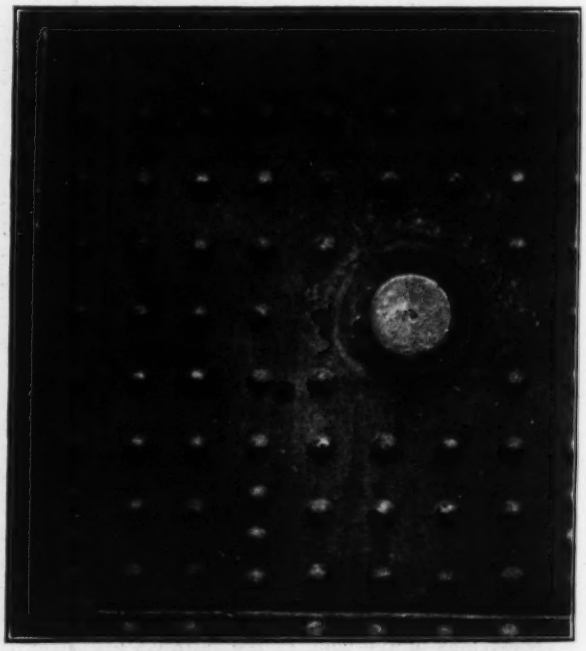
It was found that practically all of the excessive wear occurred at the bottom-chord panel-points of all three spans, although a few top-chord points also required repairs. At the main panel-points wear took place both in the webs of the chords and in the pins. In general, the main web members were either absolutely tight on the pins or reasonably so. Wear at the few top-chord points which required attention was undoubtedly caused by reversal of stress in the web members and by movement of the web members following the wear in the bottom-chord pin bearings.

At the lower pins of the subhanger bars, wear had occurred in the eye-bars to such an extent that a considerable deflection took place in the bottom chords under train load before these bars were brought into action.

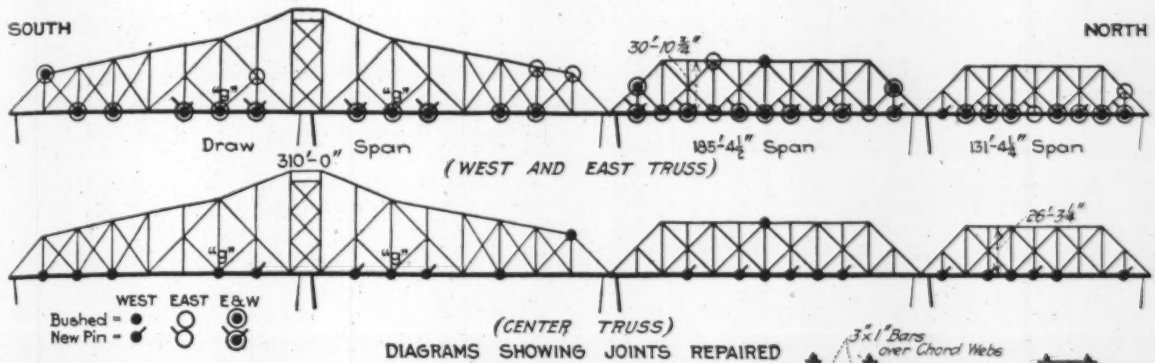
The wear in the inside webs of the side-truss chords was generally greater than in the outside webs, due to deflection of the floor troughing under load.

Raising the Sagged Ends of the Swingspan

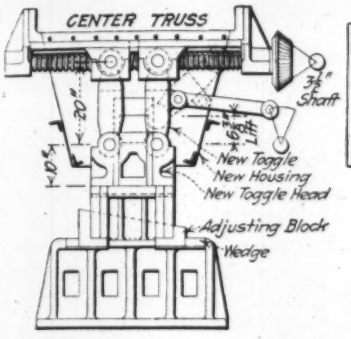
The wear in the pin bearings of the swingspan had caused the ends to sag, necessitating the lowering of the end-lift wedge blocks about 1 in. to provide clearance during the opening of the span, with a consequent reduction in the lift of the same amount when the span was closed. This condition produced high stresses in some of the truss members. It had to be remedied be-

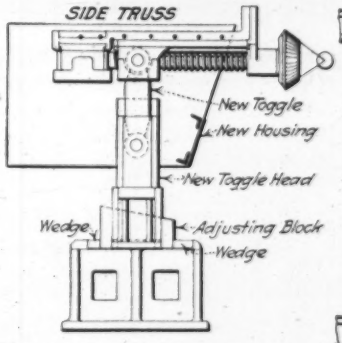


WEAR AT A SWINGSPAN MAIN PANEL-POINT

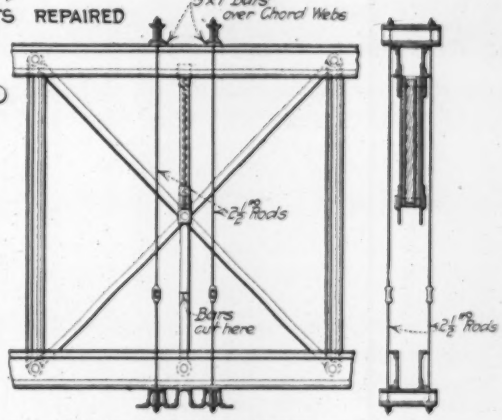


DIAGRAMS SHOWING JOINTS REPAIRED

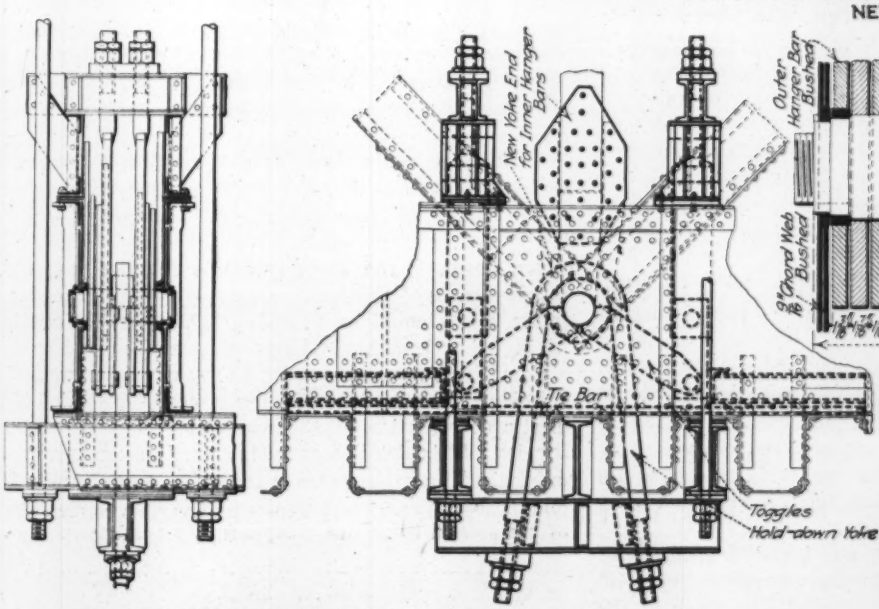




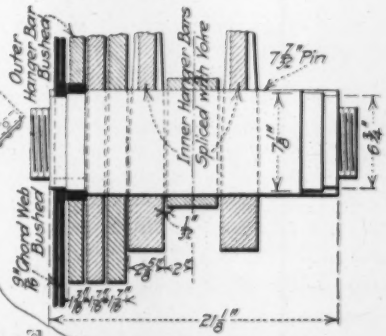
END LIFT REBUILT WITH SHORTER LINKS AND DEEPER SHOE TO INCREASE LIFT



SUPPORTING SUBPANEL POINT TO PLACE NEW PIN



RIG FOR SUPPORTING PIN AT MAIN PANEL-POINTS FOR BORING AND BUSHING



DOUBLE BUSHINGS AT "g" IN SWINGSPAN

PIN-REPAIR DETAILS NEW YORK CENTRAL'S FOUR-TRACK SWING BRIDGE OVER HARLEM RIVER, NEW YOK CITY

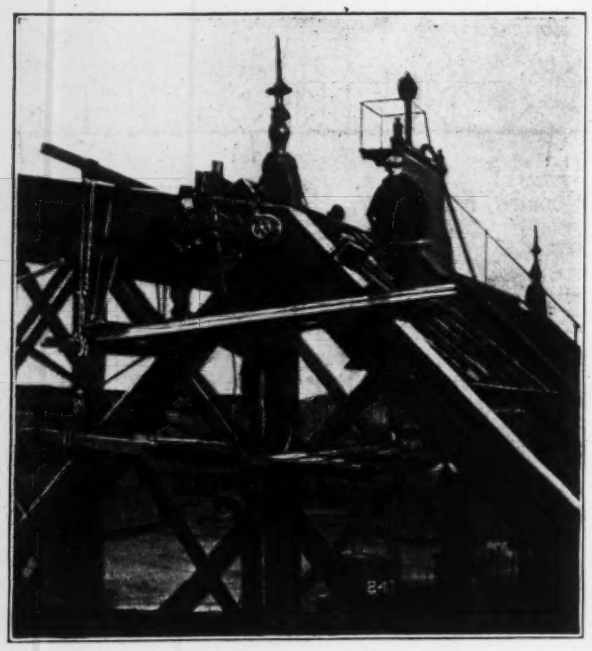
fore the pin conditions could be corrected, if satisfactory stress conditions were to be obtained.

The end-lifting device of the swingspan consists of toggle-head castings moving vertically in guides attached to the trusses and operated by means of toggle castings. The toggle castings are attached at their upper ends by pins to nuts moving in horizontal guides which are operated by screws attached to the operating machinery. The lower ends of the toggle-head castings rest on adjustable cast-steel blocks.

The desired additional lift could not be obtained by raising the adjustable blocks, as the latter would in that case have interfered with the swinging of the span. It was necessary, therefore, to provide deeper toggle-head castings, compensating for the additional depth by shorter toggle castings which provided greater vertical movement with the same horizontal movement of the nuts.

Various methods for restoring the defective pin bearings of the structure were considered. Falsework could

have been placed under the fixed spans with litttle difficulty, but would have been entirely impracticable under the swingspan. To have replaced the pins at the main panel-points with pins of larger diameter would have



BORING MACHINE WORKING AT HIP OF DRAWSPAN

necessitated boring through all the web members which were tight and would have entailed very difficult and costly field work. Because of these limitations it was decided to bore out the pin holes in the chord webs and turn down the pins a sufficient amount to produce concentric surfaces, and to fill the resulting spaces with steel bushings.

To repair the defective pin bearings by the method finally decided upon it was necessary: (a) To design a portable boring machine which could be operated in the limited space available and could be readily handled and which would bore out the pin holes in the chords and turn the pins down simultaneously. (b) To design a device which would transmit the stresses from the web members to the chords, relieving the chord pin bearings, and which would hold the pin with absolutely no displacement from passing train loads.

The design of the machines was taken up with one of the large machine-manufacturing companies, but, inasmuch as no guarantee of results could be obtained, the machines were designed, tested and built at the railroad company's West Albany shops under the supervision of H. Wanamaker, superintendent of shops.

The Boring Machine Operated by Air

The machine consists, briefly, of a tool head holding the cutting tools, provided with both automatic and hand feed and driven through a train of gears by an air motor. The tool head is guided by a sleeve threaded to fit the thread on the end of the pin. This method of attachment serves the purpose of centering the cutting tools exactly.

The tool head bears three cutting tools placed 120° apart. The first tools used were arranged so that one tool made a cut on the outside, another on the inside and a third made the finishing cut. This arrangement, combined with a slight tendency of the tools to crowd inward, produced a very small shoulder in the bore. The later tools furnished were made so that each tool cut the full width, which eliminated the tendency to form shoulders. The spring in the tools also produced a slight taper in the cuts, which was considerably reduced by slow hand feeding. It is thought that with the experience obtained on this work new machines could be designed which would largely, if not entirely, overcome these slight defects.

The distance from the inside face of the bottom chord to the center of adjacent track is about 7 ft. 6 in., which necessitated a compact machine to clear passing trains. The extreme dimension of the machine from face of tool head to end of feed screw is about 19 inches.

Adjustable Rig To Hold Pin During Boring

The device used to hold the pins during the boring operations consisted of a yoke and two opposing pairs of thrust toggles. The yoke bore on the pin midway between the chord webs and extended down through the floor troughing to anchorage beams. The toggles, one pair on each side of the yoke, extended downward at an angle of about 30° and were pin-connected at their lower ends to vertical hangers extending upward through crossbeams resting on the top of the chord. The lower ends of the toggles butted against stiffener angles riveted to the chord and tied together by a horizontal tie-plate which took the thrust from the toggles.

This device, which is shown by drawing herewith, was designed to transmit all stresses from the web members to the chords which normally are taken care of by the bearing of the pins on the chord webs. At the center truss, however, the space available for the yoke and toggles was so limited that only a portion of the maximum stress could be provided for, necessitating the boring of such points at times when traffic could be restricted to the outside tracks. Very careful stress calculations were made, including a computation of the elastic deformation of the material in the yokes and toggles. This detailed investigation was necessary in order that the holding device might be so designed as to eliminate any movement of the pins during the passage of trains and to reduce vibration to a minimum.

Starting the Field Work; Boring Machine Works Well

Large-scale drawings were made of each panel-point, showing the various parts assembled and giving detailed directions to the field forces, to insure that each move would be made expeditiously and in proper order. There was little precedent upon which to base this work, and its success depended largely on the ability of the yokes and toggles to hold the pins absolutely centered. Fortunately, no great difficulty was experienced in placing the holding device, and it was found that by adjusting the nuts on the yoke and hangers the pin could be moved in any direction a sufficient amount to take up in the diagonal bars the slack caused by wear.

Having adjusted the location of the pin, all nuts were tightened a sufficient amount to produce stresses in the toggles and yoke which would compensate those produced by the train load. The proper amount of tightening was determined by observing the action of the pin under passing trains.

After the holding device for the first pin had been satisfactorily adjusted, boring was begun. The action of the pin under the first train passing after the boring started was carefully observed. While there was a slight vibration, there was no permanent movement whatever in the pin. The cutting tools were reëntered and the boring completed satisfactorily.

Bushings Machined to Micrometer Dimensions

The steel bushings had been obtained rough-turned to approximately correct dimensions. After the boring was completed, the diameters of the hole and pin were calipered both inside and outside with a micrometer caliper, and the bushing was finished to an exact fit on a lathe installed at the bridge site. Finally, it was pressed into place by means of a screw-jack screwed on the end of the pin and operated by a 5-ft. lever.

Having encountered no insuperable difficulties on the first pins repaired, the work proceeded. The repair of the two approach spans, which involved fewer difficulties than did that of the swingspan, was undertaken first. Due to the differences in the packing of the members on the various pins, it was necessary to obtain a number of different yokes, toggles, etc., although in some cases the same material could be used a number of times.

In the repair of the worn pin bearings of the subhanger eye-bars, it was found impracticable to bush the eye-bars themselves. At these points, the pin holes in the chord were bored the same as for the main panel-points which were bushed. After boring, the pins through the lower chord and the lower ends of the eye-bars were removed and replaced by new pins and bars, the latter being spliced to the old upper sections (see view). While the pins and eye-bars were being replaced, the bottom chord was supported from the top chord by means of four adjustable rods, as shown in sketch. These rods were tightened a sufficient amount to take approximately the same dead-load stress as originally existed in the bars.

BORING COMPLETED, READY FOR BUSHING

THE BUSHING BEING PRESSED IN BY SCREW-JACK BORING MACHINE IN PLACE AT HIP JOINT

Practically all of the boring and the placing of bushings was done at night, between midnight and morning, to minimize interruption to the continuity of the boring by the passage of trains.

After a number of bushings had been placed, there was found to be a tendency of the bushings to work out due to the slight taper mentioned above. This was corrected by inserting three small tap screws in each bushing, 120° apart, the center line of the screws being on the lines of division between the bushings and the chord webs.

Work on the approach spans was started in the field about Nov. 1, 1916, and was completed about Mar. 1, 1917, during which time 54 points were repaired.

Special Problems in the Swingspan

The swingspan presented a somewhat different and more difficult problem. As mentioned before, the wear at the pins had caused the ends of the trusses to sag, which, in turn, had caused the pins at the main panel-points to bear hard against the chord webs toward the center of the span. Boring operations could not be safely undertaken until the pins were relieved from bearing on the chord webs. It was thought that with the end-lifting devices remodeled to secure additional lift, thus removing the excessive sag in the trusses, the yokes and toggles would release the pins from bearing, and the work was planned and carried out on this assumption. The size and close packing of some truss members presented other difficulties.

After the new end-lift castings had been placed, the additional 1-in. lift at the ends was obtained by inserting shims under these castings and removing from

beneath the end rails shims of compensating thicknesses previously placed. This lift was made ¼ in. at a time. Because of the three lines of trusses and the heavy traffic, it was a slow and laborious piece of work, but it was finally accomplished successfully and produced the desired result, no difficulty thereafter being experienced in releasing the pins.

Probably the most difficult points to repair were the bearings at the lower ends of the side-truss main hanger bars near the center of the swingspan. Each of these hangers consists of four bars 10 x 1 3/8 in. The packing of the members and the method of making repairs are shown by sketch. In addition to wear at the chord bearings, there was so much wear in the eye-bar pin holes that it was considered inadvisable to simply cut and splice the bars. It was impracticable to replace the pins and the lower ends of these bars, as was done at the subhanger points, because of the difficulty of supporting rigidly the subdiagonal compression members hinging at these points, and the difficulty of providing temporary suspender rods large enough to support the points with the bars cut.

The procedure adopted was as follows: Temporary suspender rods which had been used at the subhanger points were placed, and the lower ends of the inside bars were removed, giving space for the toggles, which with the yoke and other parts of the holding device were put in place and adjusted. The chord webs and the outside bars were then bored and bushed, and the lower ends of the inside bars replaced with yokes spliced to the upper part of the bars. In this way very satisfactory results were obtained.

Except as described above, the repairs on the swingspan were of the same nature as those on the approach spans and were carried out in the same manner. Work on the swingspan was started in the field about Mar. 1, 1917, and was completed about July 1, 1917, during which time 35 points were repaired, the end lifts were remodeled, and new lift rails were installed in all tracks.

After a few points had been repaired, the men became quite expert in handling the tools and fitting the bushings, getting absolutely tight fits between the bushings, the pins and the chord webs. In fact, the results were better than was anticipated. The work was completed without any mishaps other than occasional breaking of tools, and it is thought that the tight fit of the bushings will prevent the starting of wear at these points for a considerable number of years.

The work was planned in the office of the engineer of structures, construction department, New York Central R.R., Buffalo and East, of which G. W. Kittredge is chief engineer and J. W. Pfau is engineer of construction. The field work was done by company forces under F. Boardman, division engineer, and N. W. McCallum, supervisor of structures.

Why Sewer Is Bigger at Upper End

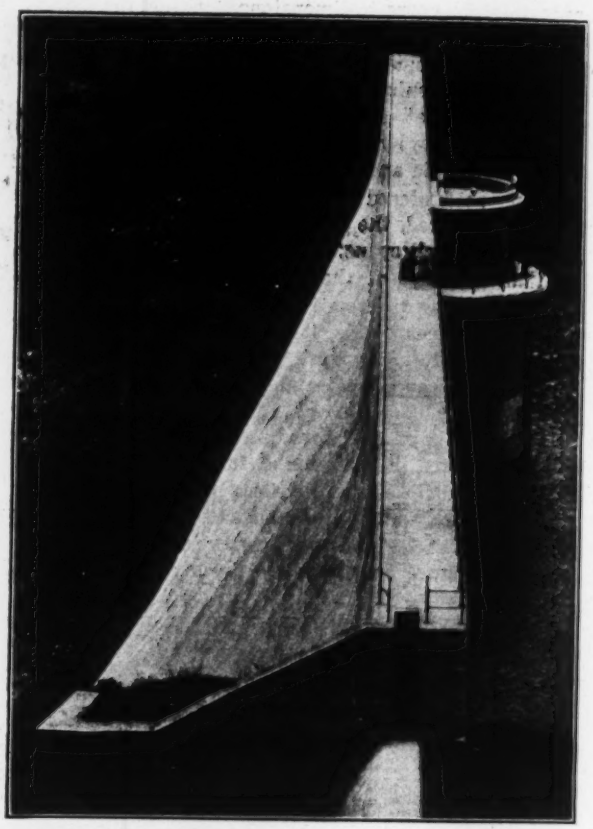
The mystery of a sewer at Youngstown, Ohio, which is bigger at the upper than at the lower end, has been explained for the benefit of the general public through the local press by Frank Lillie, city engineer. It is very simple. The upper part of the sewer carries storm water until it approaches near enough to a stream to permit overflows, which diminish the volume to be carried.

Australian Concrete Dam Impounds Billions for Brisbane

Structure 125 Feet High Filled with Rock Plums and Faced with Rich Concrete Reinforced with Steel Rods

By John Peart
Engineer for Water-Supply, Brisbane, Queensland

A CONCRETE dam of gravity section, 125 ft. high from foundation to top, designed to impound about 7,000,000,000 U. S. gal. of water, was officially put in use in December, 1916, by the Metropolitan Water Board of Brisbane, Queensland, Australia. The structure is known as the Cabbage Tree Reservoir dam and is a part of the water-works system of Brisbane and

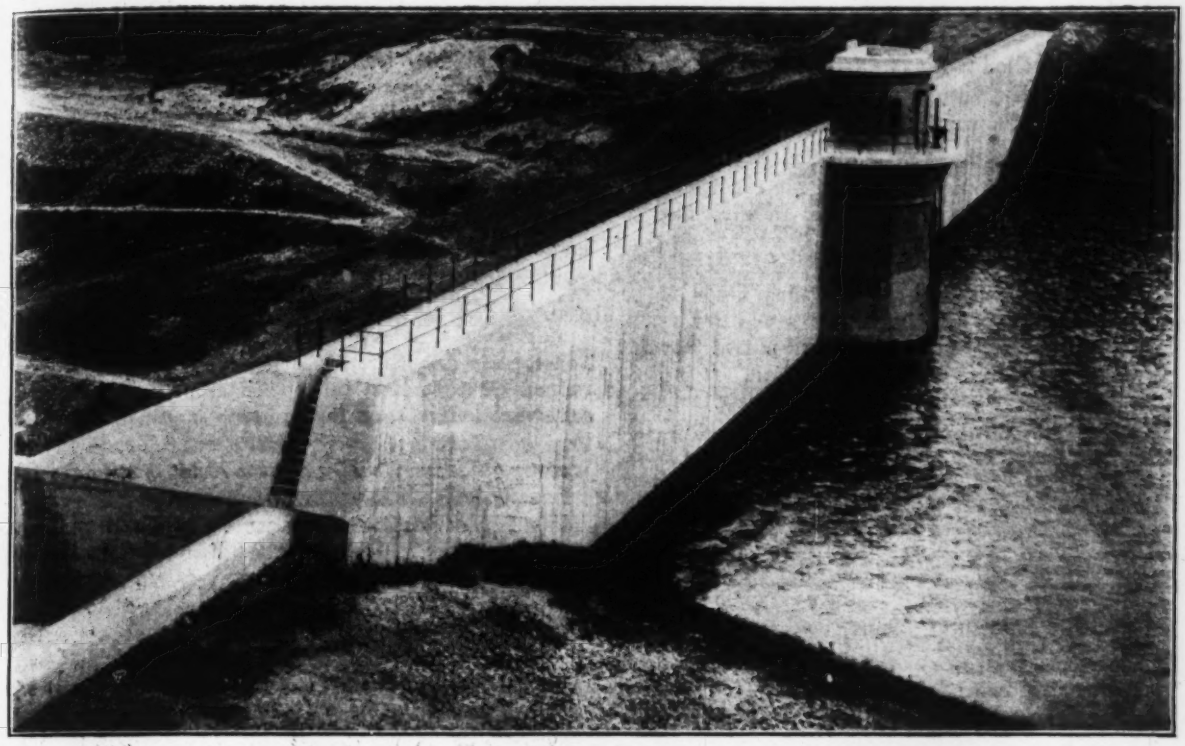


LOOKING ACROSS THE TOP OF THE DAM ITS MASSIVE BUT GRACEFUL LINES IMPRESS ONE

its suburbs, supplying a population of about 158,000 at the close of 1916. The main supply is taken from the Brisbane River, by means of a pumping station about 20 miles from the city.

The new dam is located on Cabbage Tree Creek, a tributary of the Brisbane River. The dam is 5½ miles from the pumping station, with which it will be connected by a concrete conduit. The reservoir has an area of about 700 acres and a catchment area of 28 square miles.

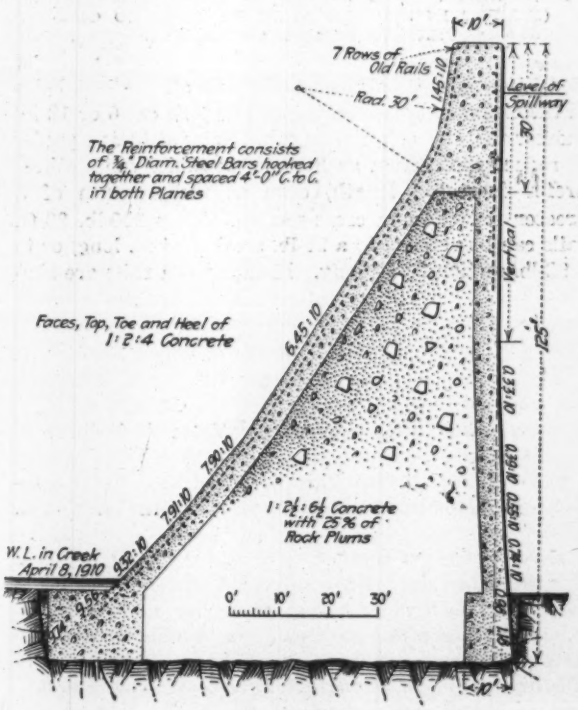
The dam rests on blue quartzite, which was found at a depth of 15 ft. below the creek bed. The dam proper is 580 ft. long, and beyond it is a spillway 160 ft. in length. The main construction quantities were: Ex-



ONE END OF THE SPILLWAY OF CABBAGE TREE DAM MAY BE SEEN AT THE LEFT

cavation, 33,222 cu.yd.; extra excavation, below assumed bottom, 5859 cu.yd.; spillway excavation, 64,500 cu.yd.; cyclopean concrete, 58,400 cubic yards.

The rainfall in and near Brisbane is intermittent. For long periods no rain falls, but periodically there are downpours. The longest known period of drought was in 1915, when for eight weeks the Brisbane River was dry. The period of greatest scarcity of water is put at 100 days. When full and after allowing for evaporation, the new reservoir will give a supply of 15,000,000 U. S. gal. a day for 300 days, or with greater economy for a longer period. At the present writing (May 16, 1917) the reservoir is within 20 ft. of being full.



THE DAM HAS A GRAVITY SECTION

The dam, reservoir and accessories, including the clearing of the whole reservoir site from detritus, were built under contract by Arthur Midson at a cost of some £172,000, or about $838,000. The work was done under the direction of the writer. E. J. T. Manchester, M. Am. Soc. C. E., is president of the Metropolitan Water-Supply and Sewerage Board.

Delivery of Concrete Materials Is a Problem for Contractors

Prompt and regular delivery of sand, gravel and stone in carloads at the site of construction cannot now be reckoned on by contractors, owing to shortage of cars and the necessity of pressing cars into military and other service. On some large works where the concreting plants are equipped to receive materials dumped from railway cars the contractors have to get material where and how they can and have it delivered by wagons or motor trucks. In Wisconsin, the railways have announced that they will handle shipments of sand, gravel and crushed stone only in certain directions, where it will not interfere with other more important traffic, and will not guarantee deliveries. This is likely to interfere seriously with concrete roadwork, and many contractors for such work are now looking for local gravel pits to supply their needs.

New Rails Made from Old

Worn Rails Rerolled to Smaller Sections—Those Made from Badly Worn Rails Given Heads of Unsymmetrical Shape

THE present high cost of steel rails and the necessity for the exercise of economy are conditions encouraging more extensive use of old rails rerolled to standard sections of somewhat reduced weight and size. A recent development, known as the McKenna Process, that allows rails with very badly worn heads to be treated in this way is being used by several railways.

In the process the rail is heated and passed through rolls which shape it to the desired section. It is considered desirable to do the work at a moderate temperature, in order to avoid changes in the character of the steel. This has made it difficult to handle badly worn rails on account of the severe draft on the relatively cold metal in forcing it to fill the section in the rolls. The result is a distortion of the metal, likely to set up internal stresses which may make the rails unreliable in service.

One Side Only Brought to Gage

To overcome this difficulty, the idea was conceived of bringing only one side (the gage side) of the rail head to standard section in the rerolling process, allowing the other (outer) side to be of smaller size to compensate for the loss of metal by wear. As the proportions of the rerolled head conform to those of the worn head, a uniform draft on the metal in rolling is obtained.

In the top left-hand rail section in the accompanying drawing the full line *A* of the outer side of the head gives the outline of the best of the worn rails, in which the heads are rerolled to a symmetrical section. The dotted lines *B* and *C* represent the outlines of unsymmetrical heads as rerolled from more or less badly worn rails. In all of these sections the base and web are symmetrical and match each other for rails of the same weight per yard. The heads of the rerolled rails may have a variable amount of metal, but have a uniform contour for the running surface and the gage side. The web and base are not altered, so that the standard splice bars can be used.

Preliminary Work and Sorting

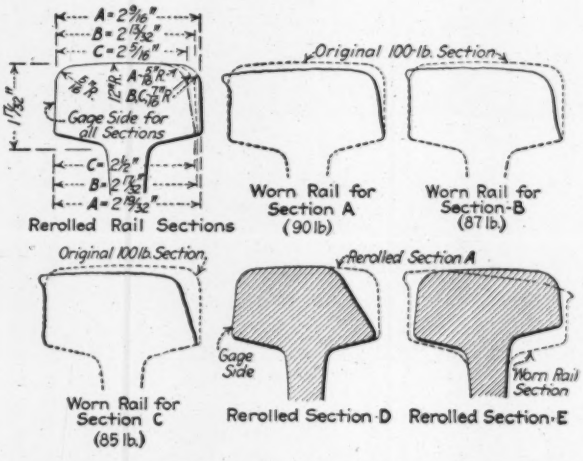
Besides the heating and rolling there is preliminary work and sorting. When the worn rails are received considerable work has to be done in grinding off the slivers and ridges caused by flow of the metal, which would break out in rerolling. The rails are then sorted, and those with the least wear are passed through rolls giving the symmetrical section *A*. The rolls are then changed to the unsymmetrical section *B* for the next best rails, and then to section *C* for the others. The rails of each section are shipped separately.

In many cases the bevel of the outer side of the rail head is not too great to permit of the rail being turned in the track after the gage side has been worn. Even if this is impracticable, as in the special rail shown in section *D*, rails which are so badly worn that they could not be rerolled at all under the original method can now be made serviceable.

A modification of the plan is to reduce both sides of the rail head to the contour indicated by the dotted lines, thus slightly reducing the width of the top rolling surface. Such a section may be used on sharp curves, or by railways which prefer an inclined side to the rail head, but in general the unsymmetrical section is preferred. A special rail for curves is shown at *D* in the drawing. This has a narrow head (for reduced friction), but is otherwise a standard rail and requires no special joints or fittings.

Ends Cropped After Rerolling

Most worn rails have the ends battered and crushed. These parts are not cropped, however, until after rerolling. The rerolled rails when cropped are usually somewhat longer than the original length, but if the


A = 2 9/16"
B = 2 15/32"
C = 2 5/16"
Gage Side for all Sections
C = 2 1/2"
B = 2 17/32"
A = 2 9/32"
Rerolled Rail Sections
Original 100-lb. Section
Worn Rail for Section A (90 lb)
Worn Rail for Section B (87 lb)
Original 100 lb. Section
Rerolled Section A
Gage Side
Worn Rail Section
Worn Rail for Section C (85 lb.)
Rerolled Section D
Rerolled Section E

THESE REROLLED RAILS HAVE ONE SIDE OF HEAD CONFORMING TO STANDARD SECTION. THE OTHER (EXCEPT IN SECTION A) IS SMALLER TO COMPENSATE FOR LOSS OF METAL

elongation is not sufficient to include all the bolt holes in the ordinary cropping, the rail may be cut 6 or 12 in. shorter than its original length. Some railways prefer to reduce the section as little as possible, while others prefer increased length, even at the sacrifice of a greater reduction in cross-section. Thus 100-lb. 33-ft. rails can be rerolled to a 90-lb. section 34 ft. long, or to a 92-lb. section 33 ft. long. If such worn rails are simply cropped for relaying in secondary track, their length will usually be 30 ft., but by rerolling they are increased in length besides having the heads reshaped.

The St. Louis & San Francisco R.R. has a 75-lb. section rerolled from 85-lb. rails, and the Chicago & North Western has an 80-lb. section made from old 90-lb. rails. The Michigan Central R.R. and the New York Central Lines (West of Buffalo) are having a 90-lb. section rerolled from 100-lb. rails. All these are of the A. S. C. E. sections.

Another type of rerolled section is shown at *E*. This has the outer side of the rail head shallower than the gage side, requiring a higher splice bar on the outside. It is used where the worn rail has insufficient metal to fill out the new section in rerolling and is designed to combine wear and strength. The section combines the two series of rail sections of the A. R. A. type, the

side with the shallow head and deep splice conforming to the A series, while the other side conforms to the B series. Rails of this section have not yet been put in service.

The process is patented and controlled by George Langford, general superintendent of the McKenna Process Co., of Milwaukee.

Water-Supply at Fort Benjamin Harrison Nears Completion

Pump Water for Training Camp from Infiltration Well and Gallery to Concrete Reservoir—Provide Chemical Treatment

THE new water-supply plant for the training camp at Fort Benjamin Harrison, near Indianapolis, Ind., has been practically completed. This post now has nearly 14,000 men. The second training camp will start Aug. 15, and it is anticipated that the maximum requirements will be for 40,000 men.

The original post was built to accommodate only one regiment, and considerable difficulty was experienced in obtaining the necessary supply. Three deep wells proved to be practically dry holes, and the fourth produced only about 150 to 200 gal. per min. The principal supply was finally obtained by connecting up a 900-ft. well which had been drilled for natural gas.

When this location was selected recently for a large training camp, the water-supply problem gave considerable anxiety. In the description of this camp in *Engineering News-Record* of June 6, reference was made to a conference between Colonel (now Brigadier General) Glenn and other officers with C. H. Hurd, consulting engineer, of Indianapolis. A recommendation for an entirely new supply was made and was approved.

Infiltration Well Sunk on Bank of Fall Creek

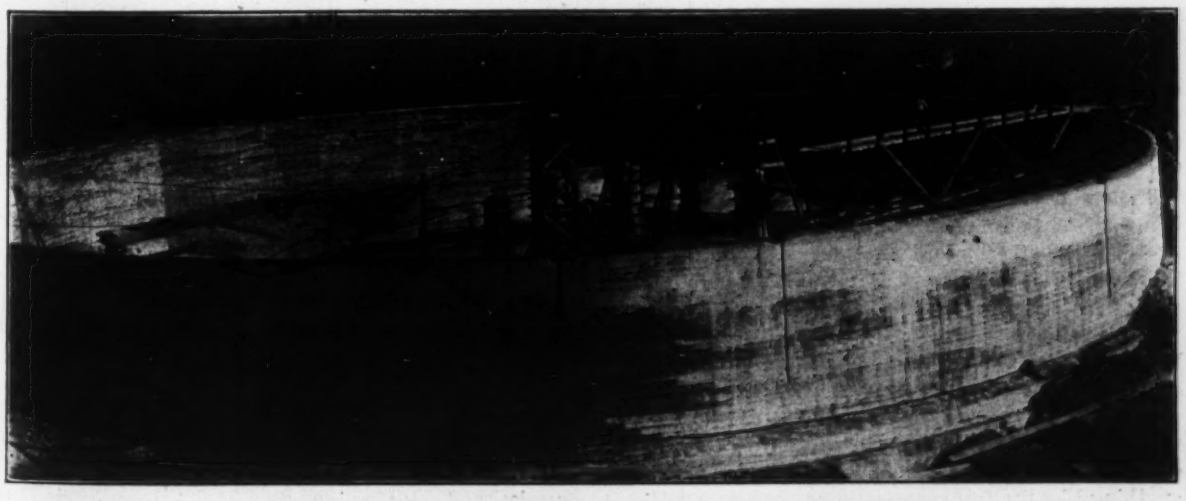
It was decided to sink an infiltration well in the gravel strata on the bank of Fall Creek, with an emergency connection to this creek, at a point above the reservation and above the intersection of Indian Creek. The infiltration well and gallery are designed to supply at present a maximum of 2800 gal. per min. The whole plant is laid out with the idea that the demand may reach approximately 6,000,000 gal. per day. For such an amount, however, it would be necessary to extend the gallery. The depth of well and gallery is about 24 ft. below the surface. The pumping station is built directly over the well and is of colonial brick to conform to the general architectural design of the garrison buildings.

A reinforced-concrete reservoir of not less than 3,000,000 gal. has been built. This is circular and conforms to the dimensions of the Bedford reservoir designed by Mr. Hurd and described in *Engineering News-Record* of July 5. It is of a thin, reinforced-concrete type, designed to give the maximum capacity for a minimum cost. It is 160 ft. in diameter. The lower 12 ft. of the circular wall will be covered by an embankment. On the upper 4-ft. exposed portion of the outside, the concrete is rubbed and washed to give a smooth surface.

The reservoir was built in exceedingly short time. Plans were started immediately, and the work was begun by the Gaylord Engineering and Construction Co. about June 1. The actual time from beginning the excavation to the completion of the reservoir did not exceed 30 working days.

The Whole Supply Will Be Chlorinated

The infiltration well supplies water of excellent quality and abundant quantity. As a precaution, chlorinators are being installed by the Wallace & Tiernan Co., for disinfecting all water used at the fort. Provision is also being made to use sulphate of alumina as a coagulant in case an emergency makes it necessary to use water from Fall Creek. There are three electrically driven Hill-Tripp centrifugal pumps, each having a capacity of 1400 gal. per min. These pump against a head of about 100 ft. and deliver water into the new reservoir. Three similar pumps of 1000 gal. capacity each are installed in the old pumping station which furnishes the pressure supply to the fort. These will be used as auxiliaries for general supply and fire service for both the garrison and the cantonments. The mains are all of cast iron and are laid to a depth to insure against freezing.



CONCRETE RESERVOIR FOR NEW TRAINING CAMP AT FORT BENJAMIN HARRISON HAS 160-FT. DIAMETER

A New Niagara Would Develop 2,000,000 Horsepower

Construction of Large Dam in Gorge Below Present Falls, at Foster's Flats, Would Create Waterfall 100 Feet High

By T. Kennard Thomson
Consulting Engineer, New York City

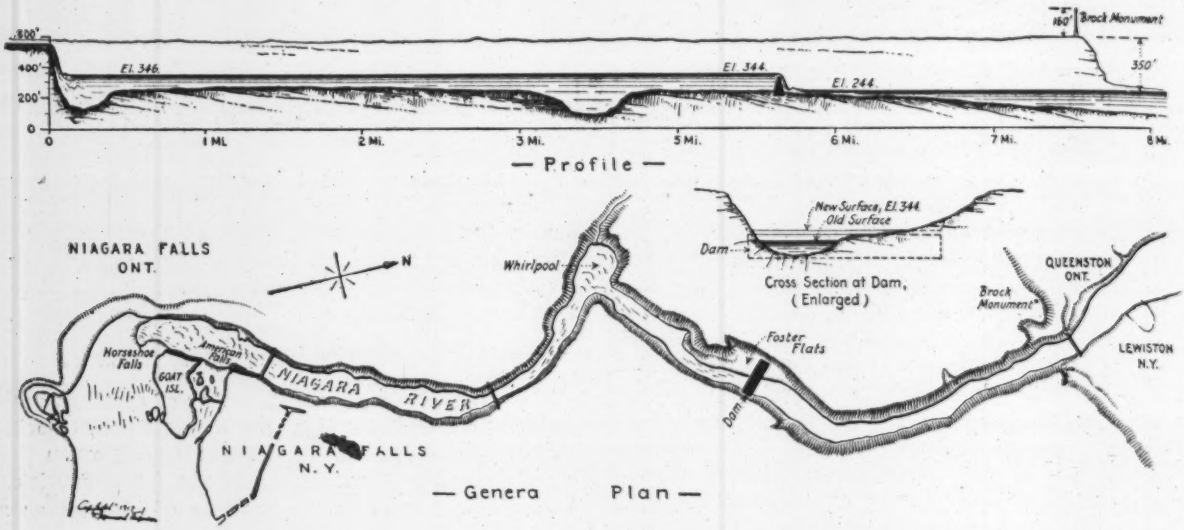
THE existence of a scheme to build a large dam in the Niagara River below Niagara Falls has been widely known, but nearly every engineer to whom the author has spoken recently and many laymen have asked how we were going to build the dam in the Niagara River. Therefore, the inclosed plan showing the location of this dam and development should be of much interest to many readers, and the author has pleasure in first publishing it in *Engineering News-Record.*

Almost everyone remembers the lower Niagara River as running through a narrow gorge which is about 500 ft. wide at the water line and about 1000 ft. between the tops of the banks standing from 300 to 350 ft. above the water; and all realize the naturally great difficulty of a dam in such a location.

They do not notice, or else forget, the place called Foster's Flats, a beautiful spot on the Canadian side where there is quite a low shelf with easy slope to the top of the bank. A glance at Foster's Flats on the map will show at once how this simplifies the work; more than half of the dam can be built on dry land. This first half will then afford an easy means of diverting the water from the present channel before building the rest of the dam, where the water now flows.

There is a 102-ft. drop in the Niagara River from the base of the old falls to Lewiston, with a minimum flow of 220,000 cu.ft. per sec. Now, this total head and volume should be developed as a unit—in one large dam. Otherwise the public would have to pay for a number of disconnected power plants which could not develop anything like the full value of the river and would—as stated in my letter published in your issue of July 1—result ultimately in the destruction of all the power plants below the falls by ice. The most economical method in developing the river, of course, is to use as much water at the falls as the Governments will allow, afterward returning the water to the river directly below the falls so that it can be used over again at the proposed new falls made by the dam at Foster's Flats, about 4½ miles below.

As to the dam and power houses, little more need be said at this time. The masonry structure will be about 1200 ft. long and 150 ft. high, and it will raise the down-



A LARGE DAM IS PROPOSED IN THE GORGE BELOW NIAGARA FALLS

stream level of the river about 100 ft. The power houses would extend downstream from the dam on both the Canadian and American sides, considerable distances being required to accommodate the many turbines necessary.

Michigan Has New Experimental Flume

A new experimental hydraulic flume, built through the generosity of the Detroit Edison Co. at its Argo dam at an expense of $1300, has been opened for the use of the Engineering College of the University of Michigan. The flume has a total length of 138.42 ft., 36.1 ft. of which is 8 ft. wide and 8.75 ft. deep, while the main testing section, which is 102.42 ft. long, is exactly 6.56 ft. wide and 8 ft. deep. The flume is equipped with two sets of adjustable baffles, one set being vertical and one horizontal. It has at one end a standard Bazin weir, with an installation of four gages for observing the "head." The capacity of the flume and the available water-supply at practically a constant head give this flume the distinction of being excelled by no other experimental flume in this country. It has proved absolutely water-tight, so that no leakage corrections have to be introduced into the experimental calculations. It will prove of great value in experiments with aërated and submerged weirs, V-notch weirs, free and submerged orifice, current meters, pitot tubes, chemical and color gaging, etc.

How Temperature Varied in Two Dams While the Cement Was Setting

Thermometer Readings in Large Structure Showed an Increase of 44° F. 14 Days After Pouring—Thin Arch Showed Only Slight Increase, Affected by Weather

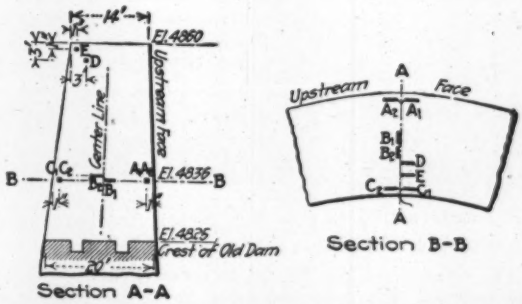
BY R. A. MONROE

IN PLANNING the recent 40-ft. height increase of the large Lake Spaulding dam of the Pacific Gas and Electric Co. in northern California, it was decided to determine how temperatures varied within the concrete. Accordingly, as the work was under way, thermometers in the shape of thermocouples were put in at predetermined locations so that records could be kept. The construction was begun last year at about the same time that the company built a dam of the multiple-arch type, and it was decided to apply the same tests to both structures so that the effect in thin arches might be compared with that observed in a structure of large section.

In the large dam the thermometers were located both at the center and near the surface, while in the thin arches only the central location was used. In every case the instruments, which consisted of resistance coils incased in copper tubes, were put in in pairs so there would be a check on all readings. The wires from the instruments were led to the outside through lead cables and connected to a Wheatstone bridge. Readings were taken on a scale calibrated to give the temperature in degrees Fahrenheit.

RESULTS AT SPAULDING DAM

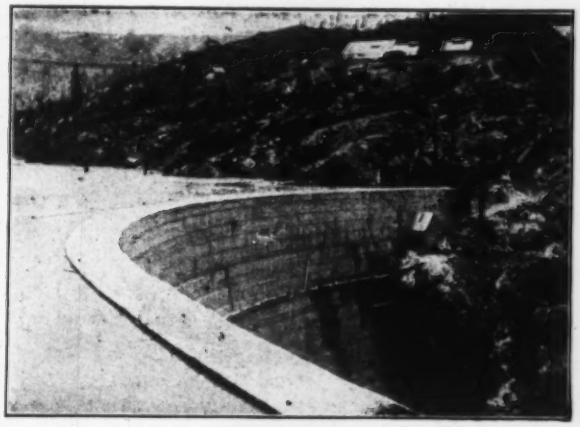
The addition to the Lake Spaulding dam consisted of about 15,000 cu.yd. of concrete, raising the dam from El. 4820 to El. 4860. The concrete used was a 1:3:6 mix of the Golden Gate and Standard Napa Junction brands of cement, Marysville sand and Natomas rock ½ to 3 in. in size. The concrete was mixed in 1-yd. batch mixers,



LOCATION OF THERMOMETERS IN THE SPAULDING DAM

spouted from the mixer house to the dam and then conveyed to place by side-dump ore cars. The yardage placed varied from 300 to 700 cu.yd. per day.

As shown in one of the accompanying sketches, three sets of two thermometers each were installed at El. 4838, 24 ft. from the top of the dam, set *A* being 1 ft. from the upstream face, set *B* at the center, and set *C* 1 ft. from the downstream face of the dam. These were all put in on Oct. 5, 1916, in soft concrete placed that day to a depth of 3 ft. and completed to El. 4845 on Oct. 6. On Oct. 21, 1916, thermometer *D* was placed at El. 4857, 3 ft. from the downstream face, and on Oct. 22 thermometer *E* was installed at El. 4859, 1 ft. from the downstream face.



WATER IS NOW 260 FEET DEEP BEHIND THE SPAULDING DAM

TABLE I. TEMPERATURE READINGS FOR SPAULDING DAM

Date		Air Temperature, Max.	Min.	Concrete Temperature in Degrees Fahrenheit— A	A	B	B	C	C	D	E
Oct.	5	46	36	48.0	48.0	47.5	47.0	47.0	53.0	....	....
	6	48	36	54.0	53.5	55.0	55.0	53.5	60.0	....	....
	7	40	34	58.0	58.0	62.0	62.0	56.0	62.5	....	....
	8	48	32	61.0	61.0	68.0	68.0	59.5	65.0	....	....
	9	48	40	63.0	63.0	71.0	72.0	59.0	64.0	....	....
	10	54	38	67.0	67.0	77.0	78.0	61.0	66.0	....	....
	11	50	38	68.0	68.0	80.0	81.0	60.5	66.0	....	....
	12	66	32	69.5	69.5	83.5	85.5	61.5	67.5	....	....
	13	64	38	71.5	71.5	86.0	87.5	64.5	71.5	....	....
	14	72	34	72.5	72.5	88.0	89.0	66.0	72.5	....	....
	15	72	38	73.5	73.5	89.0	90.5	68.0	75.5	....	....
	16	80	40	75.0	75.0	90.0	90.5	70.5	78.0	....	....
	17	78	48	75.0	74.5	90.0	91.0	70.5	77.5	....	....
	19	72	40	73.0	73.5	89.5	91.0	69.0	77.0	....	....
	20	73	36	72.5	72.5	89.0	90.0	68.5	76.5	....	....
	21	74	36	71.5	71.5	88.0	89.0	66.5	74.0	55.0	....
	22	68	34	71.0	71.0	87.5	88.5	66.5	73.0	....	53.0
	23	66	34	....	....	....	....	....	....	65.5	54.0
	25	70	32	69.5	69.5	86.5	87.0	67.0	76.0	....	....
	26	76	44	69.5	69.5	86.5	87.5	65.0	74.5	....	....
	27	68	32	69.5	69.0	85.5	85.5	67.5	76.5	78.5	61.5
	29	62	34	68.0	67.5	84.5	84.5	66.0	....	....	....
	31	64	28	66.5	66.0	83.0	84.0	64.0	....	....	....
Nov.	2	68	30	65.0	64.5	82.5	82.5	63.0	....	....	....
	3	64	30	....	....	....	....	....	....	76.0	60.5
	4	48	34	63.0	63.0	81.0	82.0	61.5	....	....	....
	7	44	18	62.0	61.0	80.5	80.5	59.0	....	....	....
	10	66	34	60.0	59.0	79.0	78.0	57.5	....	....	....
	12	42	18	58.5	58.5	78.5	78.0	55.5	63.5	....	....
	17	64	32	56.0	56.0	75.0	75.0	55.0	64.0	57.5	48.0
	19	48	32	55.5	55.5	74.0	73.5	54.5	63.0	58.0	46.0
	21	66	38	....	....	....	....	....	....	57.0	47.0
	26	50	29	45.0	45.0	66.5	67.0	48.0	57.0	50.0	40.5
Dec.	5	44	40	40.0	40.0	60.0	61.0	42.0	50.0	41.0	35.0
	13	60	33	40.0	36.5	54.0	55.0	43.5	53.0	38.5	35.0
	21	38	28	40.0	36.0	51.0	51.5	42.5	51.0	38.0	35.0
1917 Apr.	16	45	10	34.5	34.5	38.5	37.0	32.5	41.0	36.5	28.0

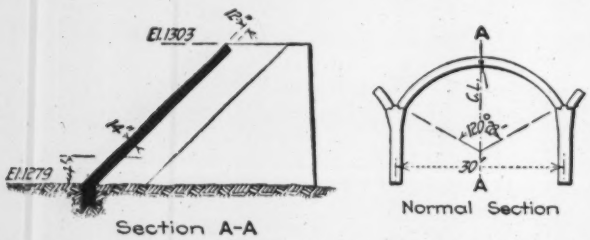
Note—Thermometer C2 read about 6° above C1 from the start, due to an error in the instrument.

The temperature of the freshly placed concrete, as shown by the table, was 47° to 48°, and in 11 days the temperature across the entire section had risen notably. At the upstream face the gain was 27°, 22.5° at the downstream face, and at the center the increase was 43°, or roughly, twice as much as at the faces.

In two months the temperature of the concrete 1 ft. from the faces of the dam had returned to normal atmospheric temperature (about 40°), while that of the center of the section was still 20° above normal atmospheric temperature and falling at the rate of about 3° per week. This indicates that the temperature at the center of the section would not return to normal until about four months had elapsed from the time of pouring, two months longer than was required for the concrete at the faces. A reading taken over six months from the time of pouring showed the concrete at the center to be 4° above that at the faces, but at practically the mean atmospheric temperature for the preceding month.

Thin-Arch Results Were Different

The Rock Creek dam is a multiple-arch reinforced-concrete structure, consisting of thirty-five 30-ft. arches, giving a crest length of 1050 ft. The maximum vertical height of arch is 35 ft., the arch axis being inclined



LOCATION OF THERMOMETERS IN THE ROCK CREEK DAM

at an angle of 45°. The normal thickness of the arch at the top is 12 in., and this increases 1 ft. in thickness for each 10 ft. of vertical depth.

The concrete mix used for the arch rings, determined after a long series of field tests, consisted of one part tested Golden Gate cement, 1½ parts Marysville sand, 2½ parts rock ranging from dust to ¾ in., and 2½ parts rock ¾ to 2½ in. in size. The concrete was mixed in a ½-yd. mixer located at one end of the dam and delivered by means of side-dump ore cars running on a trestle built up to an elevation of 8 ft. above the top of the arches.

Assumed Rise of 10 Degrees

The arch was designed with two hinges, these being in the concrete and located at the points where the arch ring joins the buttress. This design was adopted to reduce the binding stresses due to temperature and shrinkage, which were found to be excessive for an elastic or hingeless arch. It was assumed that, due to the chemical action of the cement, the setting temperature of the concrete in the arch rings would be 10° above the average daily temperature.

The two thermometers inserted in the dam, as indicated in the sketch, were read three times a day, and as their readings checked very closely, the accompanying table was made up from the mean of the two readings. After the first six days the atmospheric temperature was recorded at the time of taking the concrete temperature, but the maximum-minimum temperature readings are from the United States Weather Bureau station at Colfax, located about 15 miles north of the dam, but which has practically the same climatic conditions.

The mean temperature for this locality for the period over which the above readings extend is 45°, and the maximum temperature attained by the concrete in setting is 62°, or a rise of 17° above the mean. From this it would appear that the assumption of a 10° rise was a little low. The results also show that the highest temperature was attained in about 18 hours after pouring, or shortly after the concrete had taken its permanent set, but that this temperature was maintained for only a few hours.

TABLE II. TEMPERATURE READINGS FOR ROCK CREEK DAM

		Temperature in Degrees Fahrenheit			
			Atmosphere		
			At Dam	At Colfax	
Date	Time	Concrete		Max.	Min.
Jan. 20	1:59 p.m.	55.0	..	59	24
	4:50 p.m.	54.1	..	..	..
21	8:00 a.m.	62.1	..	49	32
	12:45 p.m.	61.8	..	..	..
	4:50 p.m.	62.5	..	..	..
22	9:30 a.m.	49.4	..	50	29
	12:45 p.m.	50.5	..	..	..
23	8:15 a.m.	41.5	..	54	29
	12:45 p.m.	42.8	..	..	..
	4:50 p.m.	46.8	..	..	..
24	8:15 a.m.	38.2	..	60	40
	1:00 p.m.	40.7	..	..	..
	4:50 p.m.	45.2	..	..	..
25	8:15 a.m.	39.9	..	60	30
	1:50 p.m.	43.2	..	..	..
	4:50 p.m.	47.0	..	..	..
26	8:00 a.m.	40.4	..	60	30
	1:00 p.m.	42.8	56	..	..
	4:50 p.m.	47.2	56	..	..
27	8:00 a.m.	41.8	42	55	37
	12:50 p.m.	43.0	53	..	..
	4:30 p.m.	45.5	51	..	..
28	8:00 a.m.	42.7	44	50	35
	12:00 m.	41.8	46	..	..
	4:30 p.m.	41.8	..	..	..
29	8:00 a.m.	40.5	46	42	38
	12:00 m.	40.7	47	..	..
	4:30 p.m.	41.0	47	..	..
30	8:00 a.m.	39.9	45	45	37
	1:30 p.m.	40.4	46	..	..
	5:00 p.m.	42.9	44	..	..
31	8:00 a.m.	33.6	34	47	24
	12:00 m.	35.1	43	..	..
	4:30 p.m.	38.6	44	..	..
Feb. 1	8:00 a.m.	32.5	35	52	30
	12:00 m.	32.5	42	..	..
	5:00 p.m.	39.0	45	..	..
2	8:00 a.m.	35.4	33	62	32
	1:00 p.m.	39.0	54	..	..
	4:45 p.m.	42.0	50	..	..
3	8:00 a.m.	39.5	36	63	36
	1:00 p.m.	43.8	56	..	..
	4:45 p.m.	46.8	57	..	..
4	7:30 a.m.	41.9	42	71	35
	1:00 p.m.	45.5	60	..	..
	4:00 p.m.	49.7	62	..	..
5	7:00 a.m.	45.6	62	71	44
	1:00 p.m.	48.0	59	..	..
	4:15 p.m.	51.3	62	..	..

It is interesting to note how closely the temperature of a concrete wall of this thickness (14 in.) follows that of the air, and these results indicate clearly that in a structure of this type provision must be made for a temperature variation of approximately the same magnitude as shown by atmospheric temperature records.

Rock Creek dam was designed by the writer under the direction of H. C. Vensano, civil and hydraulic engineer of the Pacific Gas and Electric Co. The Spaulding dam addition was also designed under Mr. Vensano's direction and built under contract by Twohy Brothers, with O. W. Peterson, superintendent of construction for the Pacific Gas and Electric Company.

Kentucky Road Department Has Standard Bridges

Standard Designs for State-Aid Structures—Small Spans Concrete Girders, Large Ones Steel Trusses

FOLLOWING the passage of a state-aid road law, the Department of Public Roads of Kentucky started the preparation of a series of standard bridge designs, to be furnished all bidders on roadwork. These bridges were all designed for the same loading and for a width of at least 16 ft., the increase in heavy loads and in traffic making it necessary to dispense with the old-time "secondary" road where less strict load and width requirements might be safe.

Structures Vary with Span

Standard designs have been prepared for the following types of structures:

Concrete Spans

Openings from 3 sq.ft. to 24 sq.ft. inclusive—concrete box culverts.

Spans from 2 ft. to 20 ft. in clear inclusive—reinforced-concrete flatslabs.

Spans from 16 ft. to 30 ft. in clear inclusive—reinforced-concrete T-beam spans.

Spans from 32 ft. to 42 ft. in clear inclusive—reinforced-concrete through girder spans.

Steel Spans

40 ft. to 80 ft. c. to c. bearing inclusive—low riveted trusses.

85 ft. to 130 ft. c. to c. bearing inclusive—through riveted trusses.

135 ft. to 175 ft. c. to c. bearing inclusive—through pin connected trusses.

Alternate plans are being prepared for spans 130 to 150 ft. inclusive, with riveted connections. No attempt has been made as yet to issue standard plans for arches, although they are recommended wherever foundation conditions would justify.

Concrete Designed for Easy Fieldwork

It has been the attempt of the department in designing its standards for concrete bridges to employ designs which could be easily and readily cast in the field and which would insure a pleasing appearance with the most economical forming. All concrete bridges in addition to their own dead weight have been designed for a covering weighing 120 lb. per sq.ft. of roadway and for a live-load of either one 15-ton tractor or a uniform load of 100 lb. per sq.ft. The live-load above noted is increased by 25% for impact.

In the design of steel standards no attempt was made to design the spans for concrete floor alone. It was endeavored, however, to design the structures at present for a satisfactory type of wooden floor and yet strong enough to allow, at some future time, the employment of a floor of reinforced concrete.

Steel Bridges Have Fixed Requirements

It has been the endeavor of the department to comprise the following in each design:

1. To provide for the increased dead-load of a better type of flooring.

2. To allow shipment of the trusses in sections to the field and eliminate as many field rivets as possible. Further, to arrange the field rivets to be driven to the best advantage in the field.

3. To provide splices in tension members capable of developing the full capacity of the member and in compression members to develop at least 75% of the value of the member (this in addition to milled joints which in many cases have not proved satisfactory).

4. To permit free air circulation and surfaces easily accessible for painting.

5. To show in detail the required rivet spacings and the desired details of all members. This eliminates any uncertainty on the part of bridge companies in bidding and unnecessary changes and delays prior to the final approval of shop drawings.

6. To eliminate, where feasible, all secondary stresses.

Either the uniform live-load or the 15-ton tractor governed the design of the steel standards as in the case of the concrete standards, the uniform live-load employed, however, in the design of the steel spans being 80 lb. per sq.ft. of roadway for all spans up to and including the 100-ft. span and reduced thence 2 lb. for every additional 10 ft. of length until the 180-ft. span was reached. For the spans of 180-ft. and beyond, 64 lb. per sq.ft. were used in the design. Twenty-five per cent. was added to the above loads for impact.

Wooden Flooring Gives Good Results

Excellent results are being obtained from the type of wooden flooring now employed. The floor consists of 2 x 4-in. white-oak timbers laid on edge and fastened to the nailing strips by 20d. nails and to each other every 2 ft. by 16d. nails. The nailing strips are of creosoted timber and fastened to the top of each stringer by bolts. The pieces of 2 x 4-in. timber are thoroughly swabbed with hot tar along the sides in contact and laid as closely together as possible. The nailing strips are so arranged as to give a crown of 1 in. to the finished roadway.

The stringers used on the standard spans will permit the use of a reinforced-concrete or wood-block floor at a later date without change. In designing the stringers for 4-in. wooden floor or wood-block flooring, it was assumed each stringer spaced 24 in. center to center carried one-half the concentrated live-loads thereon. The maximum spacing for the 4-in. flooring allowed is 27 in. center to center of stringers. The load carried by each stringer was determined by dividing the spacing of stringers center to center in inches by 48 and multiplying by the total wheel loads on the stringer. For concrete floors it was assumed that stringers spaced 30 in. center to center carried one-half the concentrated load, and for other spacings the live-load carried by each stringer was obtained by dividing the center to center spacing of stringers in inches by 60 instead of 48 and multiplying by the total wheel loads on the stringers.

Wind Pressure Cared For

In the design of the lateral systems, the wind pressure was assumed acting in either direction horizontally at 30 lb. per sq.ft. on the exposed surfaces, as seen in elevation, and in addition thereto a horizontal live-load of 100 lb. per lin.ft. of span was assumed as acting in the plane of the loaded chord. In spans in-

cluding the 150-ft. span, no additional provision was made in end post due to the wind; however, in spans above 150 ft. in length, wind is considered. The total area opposing the wind was determined by adding together the areas of twice the vertical projection of the windward truss, railings, hub guards, blocking, flooring and ends of floor-beams.

Many bridges are allowed to rust because the rust is not readily apparent. It has appeared wise, therefore, to the department to utilize a paint for the two final field coats which will not only show the rust, but also will make a bridge clearly visible at night, and it has therefore utilized a light paint for the two field coats.

Thus the department is endeavoring to furnish the counties of Kentucky with standard plans which will not only fulfill the present conditions, but be strong enough to suffice for time to come. It will be noted no short-span steel bridges are designed, but instead reinforced concrete is employed, including the approaches to steel bridges. Every effort has been made to minimize maintenance charges.

Rodman Wiley is commissioner, and Charles D. Snead is bridge engineer in the Department of Public Roads, which has its headquarters at Frankfort, Kentucky.

Breakages of Timber Stringers Show Safe Stresses

Heavy Locomotives on Santa Fe Require Heavy-Type Pile Bridge Decks—Safe Stress About 1500 Pounds Per Square Inch

THE occasional failure of the stringers of pile bridges has been found to be pretty definitely related to the weight of locomotives operating over them. On the Atchison, Topeka & Santa Fe Ry. two kinds of stringer arrangements exist on the line, heavy and light, and the more frequent failure of stringers in the light floor construction drew attention to this relation.

All spans are 14 ft., and the stringers are made of timbers 7 x 16 in. in section, Southern (Texas or Louisiana) yellow pine, except that Oregon fir is used on lines west of La Junta. In the heavy floors used on main line and important branches there are four pieces per rail, set side by side with 1-in. clear space provided by separator washers on the through-bolts. The light floor used on some branch lines has three-ply stringers. During the past years a number of breakages of sticks in the three-ply stringers has occurred. Only one stick breaks at a time; and thus the breakages do not mean accidents, although they call for immediate repair work.

Four-Ply Construction Now Needed

It was concluded that reinforcement to four-ply construction is now needed on many of the branch lines. Studies of bending moments in stringers were made to give more certain foundation to this conclusion. Some of the failures are of the longitudinal shear or splitting type, and others are bending-stress failures. The stress investigations, however, were made with reference to bending moment alone.

The first general fact was that locomotives whose total driver weights exceed 100,000 lb. for Atlantic, 140,000 lb. for Pacific and 157,000 lb. for Consolidation engines are likely to produce breakages in three-ply stringers. On the other hand, four-ply stringers gave no trouble anywhere on the system.

The railway company's standard bridge loading produces on 14-ft. span a bending moment equivalent to E-47 loading. It produces an extreme-fiber stress of 1400 lb. per sq.in. in four-ply and 1860 lb. per sq.in. in three-ply stringers. Various actual engines used on the line gave the following bending stresses in three-ply construction: 1520, 1780, 1824, 1792 and 1740 lb. per sq.in. These figures contain no allowance for impact.

Low and High Impact Effect

The engines studied include some four-cylinder balanced compounds which produce a low impact effect, while others produce a high counterbalance-weight impact. Partly for this reason it was not possible to make a direct deduction from the facts. The final conclusion, however, was that bending stresses below 1500 lb. per sq.in. are safe, while loads whose static effect materially exceeds 1500 lb. fiber stress may produce breakages.

A. F. Robinson, bridge engineer of the Atchison, Topeka & Santa Fe system, adds the following remarks: "In general, I find it a difficult matter to fix an exact maximum unit fiber stress to be permitted in stringers with 14-ft. panels and three-ply chords.

"Generally, broken stringers occurring in three-ply chords are the only criterion.

"It is quite probable that for longer panels the fiber stress might be higher. It is also assumed that for shorter panels these fiber stresses should be reduced."

Small Railway Bridge Is Displaced by Earth Pressure

Pressure of an earth-fill on soft soil recently displaced a flat-top reinforced-concrete bridge carrying the new Indianapolis & Frankfort R.R. over the Levi Thomas drainage ditch at Frankfort, Ind. This is attributed to the pressure of a bowl or pocket of soft peat under the south abutment. That this was merely a pocket instead of an extensive formation of peat is inferred from the fact that the settlement under the embankment heaved up the ground immediately adjoining the toe of the embankment, while at 50 or 60 ft. from the embankment there was no evidence of upheaval.

The bridge itself did not settle, but the bank just south of the abutment went down 3 or 4 ft. and the pressure forced the entire structure a little to the north. Investigation showed about 18 ft. of soft material and then a hard formation. The piles under the abutment reached into the latter, but a considerable portion of their length was in the soft peat.

The heavy bank was taken out for 40 or 50 ft. south of the bridge and rebuilt with engine cinders. When this heavy material was removed, the bridge went back to some extent and then stopped. This happened some four months ago. Since that time the bridge has been in constant use, carrying the contractors' construction trains consisting of 45- or 50-ton locomotives and heavy cars. There has been no settlement of any kind and no other movement of the bridge in any direction, and it is believed that it will stand without further trouble.

Duluth Ore Dock New Type of Structure

Structural Steel Frame Carries Precast Concrete Slabs Forming Ore Pockets—Bulk Cement Wheeled Direct to Mixer for Wall and Deck Concrete Placed on Job

STEEL and concrete in unusual combination are employed in ore dock No. 2 of the Duluth & Iron Range R.R. at Two Harbors, Minn. The superstructure has a frame of structural steel, with precast concrete slabs for the bottom and front wall of the bins, while the deck and the partition walls between the bins are of concrete poured in place.

The dock is 1368 ft. long, 56 ft. wide inside the pockets with top walks outside of the pocket, and with its deck 80 ft. above the lake. There is a double row of pockets, 114 on each side, and holding 300 to 350 tons each. Transverse expansion joints are placed 144 ft. apart. The pockets are 12 ft. long, so that trains of 24-ft. ore cars can dump into alternate pockets without shifting. This length also corresponds to the 12- or 24-ft. spacing of hatches on most of the ore boats. The slope of the bottom of the pockets is 48°. The substructure consists of timber piling in a space inclosed by a timber crib and filled with lake sand and gravel. This stops below the water line and is capped with concrete to form the walls of the dock and the column footings of the superstructure. Fig. 1 shows the dock and the construction plant. Fig. 2 is a typical section and part elevation.

Building the Concrete Ore Pockets

The slabs for the front walls of the pockets are 10 in. thick, and five slabs form the necessary height. The bottom of each pocket has eight slabs 8 in. thick. The partition walls, cast in place, are 12 in. thick. These walls were made with curved fillets for the joint with the bottom and bevel fillets for the joint with the front walls. The gate opening, 7 ft. wide, is at one side of the pocket. A specially designed concrete hopper section was formed in connection with the partition at the opposite side to deflect the ore toward the opening and so cause the pocket to empty itself completely.

The slabs were cast in the railway yards and delivered to the contractors on flat-cars, which were taken out on the two outer tracks of the steel frame of the dock. The erection of these slabs was done by means of an A-frame derrick mounted on four trucks and traveling on the two middle tracks of the dock. The derrick had a 40-ft. timber boom 12 x 12 in., and was operated by a Thomas 25-hp. double-drum electric hoist, with swinging gear. Fig. 3 shows the derrick placing the slabs. At the right is a carload of slabs.

The slabs were loaded flat on the cars. Each slab had cored holes with machine nuts embedded at the base of the holes. Eye-bolts were screwed into these nuts for erecting, and cable slings were used to catch the hook on the derrick block as shown. Owing to the diagonal bracing at the top of alternate pockets, almost half of the slabs had to be lowered halfway and then landed temporarily while the cables were changed to permit of final lowering to position. The heaviest slab weighed 3 tons. The total weight of the 13 slabs for a complete pocket was 36 tons. As high as 78 slabs were set in one day.

The concrete-slab deck of the approach to the dock proper was constructed before starting the erection of the concrete slabs for the pockets and the superstructure concrete work of the dock. A double-track line leads to the dock from the railway yards, passing from the earth-fill to a timber trestle which joins the steel approach to the dock proper. This last section consists of structural-steel bents carrying steel girders and with a concrete deck 14 in. thick to carry the tracks. This section is 318 ft. long, and it is at this point that the double tracks of the approach diverge to form the four tracks of the dock proper.

Forms Supported on L-Shaped Brackets

The only feature of special interest on this section was the concrete cantilever extending beyond the steel girders to form the sidewalks. In some parts this extended 10 to 12 ft. beyond the girders. This, together with the height above ground, made the securing of the falsework a difficult matter. The forms were supported on L-shaped brackets (inverted), with diagonal bracing and a steel strap connection from the top of the bracket extending across the top of the girder. The strap hooked over the inside flange, thus making the brackets deep cantilever trusses with tension stresses at

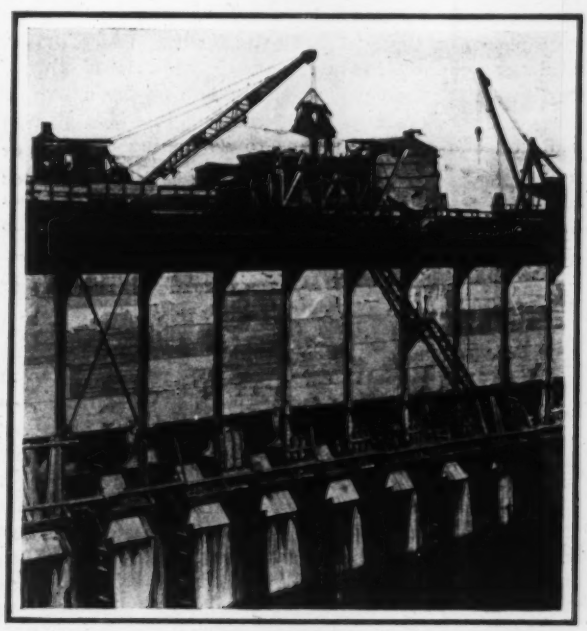


FIG. 1. PLANT AT LEFT POURS CONCRETE FOR THE DECK AND PARTITIONS; TRAVELING DERRICK AT RIGHT PLACES THE CONCRETE SLABS FOR POCKETS

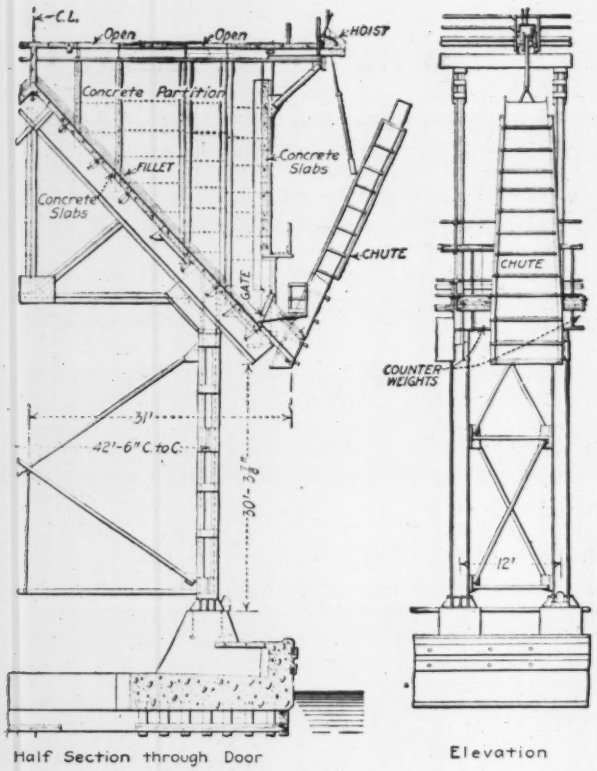


FIG. 2. ORE DOCK HAS STEEL FRAME, CONCRETE SLABS AND POURED-CONCRETE DECK AND PARTITIONS

the top transferred directly to the steel girders. The post of the L-bracket rested on the lower flange of the girders.

These brackets were about 8 ft. c. to c., and joists were placed on them to carry the forms. The ¾ x 3-in. steel strap connections across the top of the girder were made with square bends at the end to fit the flange of the girder. Before pouring the concrete a test was made on one of these straps to determine the load it would carry before straightening out at the bends. It supported a load twice that which it would receive from the concrete without showing any sign of failure at the bends.

Bulk Cement and Portable Concreting Plant

All the concrete for the dividing walls between the pockets was handled with a portable concrete plant mounted on a flat-car. A Milwaukee ½-yd. mixer driven by electric motor, together with a batch hopper, was mounted at one end of the car. The balance of the car was occupied by three material bins with sliding gates underneath to discharge onto a 28-in. conveyor belt. The conveyor was driven through friction gearing from the mixer motor, and was set at a slope steep enough to feed direct into the batch hopper of the mixer.

Bulk cement was used, the cement being taken direct from box-cars to the mixer in special wheelbarrows holding just enough for a ½-yd. batch. Where it is possible to handle the cement direct from car to mixer there are several advantages in using bulk cement. Among these are the saving in time in not having to handle the empty cement sacks, and the elimination of the usual sack losses. The gravel, crushed rock and sand were delivered on the dock in ore and gondola cars, and were handled from the cars directly into the bins of the mixer plant by means of a locomotive crane with clamshell bucket.

For the dividing walls the concrete was poured directly from the mixer to the form through swinging chutes, supported at one end from the mixer car and resting on the track rails at the other. Fig. 1 shows the mixer-plant car with locomotive crane delivering material to the bins and the form derrick farther out on the dock.

The forms for the dividing walls were built of 2-in. dressed and matched spruce with 4 x 8-in. studs not over 42 in. c. to c. The forms were built up in sections, the maximum size being about 8 x 8 ft. They were held together by ¾-in. bolts, not more than 4 ft. apart vertically and located in the studs. The fillet forms were built on as part of the form sections, the curved surfaces being covered with sheet steel. In pouring the walls, the forms were subjected to the pressure from 30 ft. of concrete placed very often in as short a time as three hours. In spite of the heavy pressures, the concrete surfaces came out very smooth and free from bulges.

A small A-frame derrick, similar to the one used for handling the slab erection, was used to erect and strip

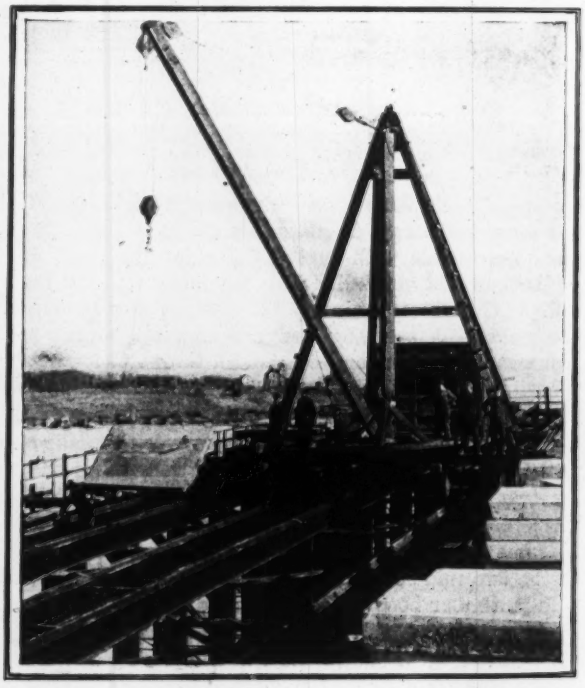


FIG. 3. DERRICK PLACING CONCRETE SLABS FOR FACE OF ORE POCKETS

the wall forms. The stripping was handled almost entirely at night, as the concrete plant when operating by day occupied the space directly over the walls which were to be stripped. The mixing plant was moved back every evening to clear the space for stripping the forms. The form surfaces were oiled on an average

every other time used. The forms were stripped about 30 to 36 hours after pouring and were transferred from wall to wall on flat-cars.

The forms for the deck slab for the dock proper were of ordinary construction, but were much cut up by openings for dumping the ore and for other purposes. The slab varies from 6 to 9 in. in thickness. The forms were made of 1 x 6-in. tamarack, dressed and matched, and made up into panels to facilitate handling, with 2-in. joists of varying depths.

Concreting the Deck in Cold Weather

The concrete for this deck slab was handled by the mixing plant described above, and for a length of about 150 ft. it was poured by chutes in the same manner. Then the weather became so cold it was necessary to provide for winter work. A boiler and heating plant had been installed on a flat-car prior to the completion of the wall work. This consisted of a 40-hp. return-tube boiler and two water tanks; one for the boiler feed and the other for hot-water supply for the concrete mixer. The latter tank was heated by steam. A locomotive tender delivered water to the tanks by means of a steam ejector. A steam connection was made to the mixer drum to inject live steam there, and the batch water tank for the mixer was heated with steam.

With this equipment it was possible to turn out concrete heated to almost any temperature desired. If concrete is too hot, however, it will set up badly in the mixer, clogging this rapidly, and will also cause checking in the finished slab work. The contractors consider 90 to 100° about as warm as it is desirable to go.

Although a comparatively thin concrete slab on top of a high structure extending into Lake Superior would not seem a very favorable place for cold-weather concrete work, there were several advantages for this work. The bottoms, fronts and dividing walls of the

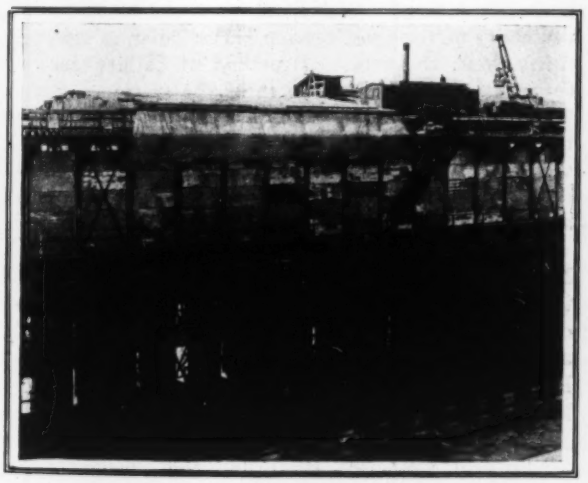


FIG. 4. TRAVELING SHELTER ENABLED THE CONCRETING TO BE DONE DURING VERY COLD WEATHER

pockets were all in place, thus shutting off the under side of the slab very effectually. The dock was provided with the four railway tracks, and there was also a substantial steel railing on each side of the dock. These points were all used to assist in housing in the deck-slab work.

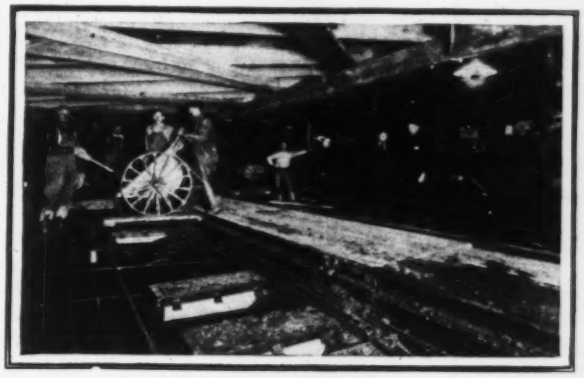


FIG. 5. PLACING CONCRETE UNDER THE TRAVELING SHELTER

The work was done under the protection of a portable housing built on four wooden ore cars. These were placed in pairs on the two center tracks of the deck, with a space of 12 ft. between the cars on the same track. Four 10 x 10-in. timbers 40 ft. long were placed across the tops of these cars, and from their ends were hung longitudinal timbers. From these last it was possible to span across to the railing with 2 x 8-in. joists. At the railing these were supported on a wooden channel section with wood wheels inside, which traveled on 4 x 8-in. sticks set on top of the steel railing.

The roof and ends of the house were made of 1-in. boards covered with tar paper. The ends extended down nearly to the concrete slab, and the slight gap was covered with a canvas flap. The sides were closed with canvas which extended down from the roof of the house to the top of the concrete slabs for the pocket front, some distance below the deck slab. Steam coils were built completely around the sides of the house and connected to the boiler car. Fig. 4 shows this traveling shed, or housing, with the boiler car at the rear. Fig. 5 shows the work in progress inside the shed.

Shelter Moved Every Other Day

Swinging doors were provided where one outside track passed through the house to permit of handling form materials from one side of the house to the other on push-cars. The house was about 70 ft. wide and 75 ft. long, being large enough to cover half of a section between expansion joints. The usual procedure was to pour a complete run inside the house in a day, wait one day to keep the protection over the concrete and give it time to set, and then move and pour the next section the next day. The mixer-plant car was attached to the house, and housed in with it, a concrete hopper extending from the front of the mixer to inside the house.

Carts were used to distribute the concrete inside the house, using wooden runways. The locomotive crane was able to move the house and mixing plant. A move of 72 ft. could be made in 5 min. after the canvas was loosened at the bottom. The use of this house enabled the dock to be completed ready for service by the opening of navigation for 1917, which was a saving of several months' time as compared with waiting for weather that would have permitted the deck-slab concrete to go in without protection. With weather vary-

ing from zero upward, it was found entirely feasible to put in the deck-slab concrete. With weather much below zero it was not found advisable to handle that class of work.

Winter Concrete Costs $2.50 Per Yard More

An item of interest in connection with the winter concrete work on the deck slab was the extra cost of this over concrete placed in more favorable weather. Aside from the initial delay due to very severe cold, no unfavorable conditions were encountered. When started, the concreting progressed at the maximum rate, very smoothly and with an unusually efficient crew of men. Yet the extra cost amounted to about $2.50 per yd. This was due chiefly to the cost of the housing, the fuel and boiler-plant attendance, increased concrete labor cost due to decreased production, cost of moving housing and cost of canvas. This is not considered excessive in view of the results achieved.

The work on this ore dock was under the direct charge of W. A. Clark, Chief Engineer of the Duluth & Iron Range R.R.; Leland Clapper was Resident Engineer in charge. The steelwork of the superstructure was made and erected by the American Bridge Co. The contract for all the superstructure concrete work, including the placing of precast slabs and pouring concrete in place, was handled by the Newton Engineering Co., of Milwaukee, Wis., with George C. Newton, Vice President, in active charge.

Simple Formula Determines When To Haul, When To Waste and Borrow

By W. C. West
Highway Engineer, Bureau of Public Works, Manila, P. I.

A SIMPLE formula by which to calculate the economical length of haul beyond which it is preferable to waste and borrow may be developed as follows:

Take two adjacent sections, one in cut, the other in fill, and each containing the same volume of material V, measured in excavation in both cases. Under this condition the material taken from the cut will just make the fill, and therefore, provided the haul from cut to fill is of a certain length, the total cost of grading the two sections, with all the material from cut used in fill, will be the same as by the system of borrow and waste. These two conditions may be expressed by the equation

$$V(a + dx/100) = V(a + b) + Vc$$

in which a equals cost of excavating and loading, in cut, per cubic yard; b, cost of hauling and dumping wasted material, per cubic yard; c, cost of borrow and fill, not rolled, per cubic yard; d, cost of hauling and dumping material taken from cut to fill, per cubic yard hauled, and x length of haul, center of gravity of cut to center of gravity of fill, in feet.

Eliminating V and a from the equation and reducing,

$$dx/100 = b + c$$

whence

$$x = 100(b + c)/d$$

Very likely d will be found practically constant for the entire job, but b and c will need to be estimated separately for each cut and fill, and will no doubt show considerable variation.

Column Tests and Formulas

Comments on the Bureau of Standards Tests from an Original Viewpoint—the Parabolic Formula

By Roberts S. Foulds
Phœnixville, Penn.

AMONG other things, good structures depend upon good specifications, and these in turn depend upon good tests and correct reasoning of the engineer and the physicist. The description of the column tests made at the Bureau of Standards, given in *Engineering News-Record* of June 28, 1917, is valuable.

The editor pointed out that, as engineers would expect, thin material makes stronger columns than thick material. He also called attention to columns which are erratic in failing at a stress considerably lower than other columns of the same dimensions and similar materials.

Failure at a lower stress is probably caused by slight defects of fabrication, by micro-flaws in the steel, or by some undiscoverable defect. Probably this erratic behavior cannot be eliminated, but it is hoped it can be improved. The greater strength of thin material affects tension tests, and probably bending tests, just as it does column tests. The erratic behavior is not peculiar to column tests; it occurs in tension tests, and the writer believes it would occur in bending tests.

Certain Sections Seem Better

Plotting the tests of light and heavy material separately brings out the fact that certain sections seem better than others. The Bethlehem H-column, not having its component parts tacked together with rivets, shows up very well, for it acts as a unit. So does the latticed column, which is made up of only two rolled main sections, test well, with the metal located in the periphery of the cross-section. The Z-bar column tests fairly well; the torsional method of failure does not seem to impair the usefulness of the section. Section 4 seems good only in short light sections. The box sections 2, 3 and 10 seem to be about medium in value. In sections 1 and 7 the metal is concentrated too near the center of gravity of the cross-section to get the best results. The tie-plate columns are, of course, poor.

Sections much more complex than those tested can be designed so that the member will buckle as a whole to a large deflection before local failure develops. Tests on the customary bridge top-chord sections are desirable, as are also tests on sections made of two I-beams latticed or with cover plate and heavy bottom-flange lattice. The writer believes that the octagonal section (such as was proposed in complex form for a bridge across San Francisco Bay) and the circular section (such as was used in the Phœnix column) would test very well indeed.

On account of erratic tests, it is idle to expect plotted results of any particular series of one cross-section to give a smooth curve for a column formula. Further, with erratic results eliminated, different sections with ends squared, as in the Bureau of Standards tests, would probably have varying degrees of end fixity, and this would give curves of different slopes.

The general trend of these tests as a whole is seen to follow the direction of the formula $36{,}000 - 0.386 \left(\frac{l}{r}\right)^2$, tangent to the Euler curve $28 \frac{E}{(l/r)^2}$ at $l/r = 216$. Perfect fixity of the ends is not to be expected—that is, a curve tangent to $4\frac{\pi^2 E}{(l/r)^2}$. In column tests with pin ends, we would expect a general slope such as is expressed by a curve tangent to $16 \frac{E}{(l/r)^2}$, which end conditions it is believed approximate the end conditions in structures. Had the length l between points of inflection in these tests been measured and the results plotted, they would probably have the general slope of a curve tangent to $\frac{\pi E}{(l/r)^2}$.

Too Few Tests To Establish Formula

Not enough lengths of any particular columns are tested to determine a column formula, even should there have been no erratic results; and it is manifest that no one formula for a steel of particular chemical combination would exactly express the facts for various sections, and for thin and thick material. For dimensioning, we shall have to rely upon a formula that best expresses averages of good tests, and the form of the formula should approximate the law that perfect columns would follow.

The writer dissents from the conclusion of the *News-Record* that "practically the entire ultimate strength of the column is to be regarded as 'available strength' for purposes of design," because the elastic limit is considerably below the yield-point, which in the stress-strain diagrams is the beginning of the gentle curve which turns toward swift failure. In columns where the stress varies from zero to the elastic limit, the latter point is the ultimate for a great number of repetitions.

It would have been very desirable to have given in the tables the elastic limit and yield-point of each column, as well as the ultimate. Of course, the elastic limit (a stress that is of great importance, because the working stress of carbon steel should be based thereon) is difficult to determine, but the expert experimenter can tell when minor permanent sets have taken place, and when the permanent set of the column (or tension member) as a whole commences. Had the elastic limits been given and emphasized, we should probably see that the ratio of the elastic limit of these columns to their ultimate is roughly equal to the ratio of the elastic limit of full-sized tension members to their ultimate.

Working Stresses Should Be Changed

When this relation is appreciated, the working stresses in most specifications will be changed. This relation is not generally appreciated, partly because of the fact that in testing small specimens the elastic limits in tension and compression are equal. The result is that the working stresses of most specifications give a greater factor-of-safety in tension members than there is in compression members.

In ordinary carbon steel, the average of good full-sized members in a testing machine will be about 54,000 lb. per sq.in. in tension (computed on the net section), and about 36,000 lb. per sq.in. in compression (computed on the gross cross-section), properly reduced for column action. The elastic limits of these carbon-steel members will average 30,000 lb. per sq.in. in tension, and 21,000 lb. per sq.in., reduced, in compression.

A curved-line formula is more rational than a straight-line formula. The writer believes that in time engineers generally will adopt a curved-line formula for this reason, and he prefers the J. B. Johnson parabolic formula $36{,}000 - 0.7\ (l/r)^2$ because it is the most rational of the practical formulas and because it probably represents the average end conditions of bridge columns. It is about as easy to use as a straight-line formula.

The American Railway Engineering specifications prescribe 16,000 lb. per sq.in. in tension, and $16{,}000 - 70\ l/r$ with a maximum of 14,000 lb. per sq.in. in compression. This column formula is roughly equivalent to $12{,}000 - 0.233\ (l/r)^2$, but if the above ratio of elastic limits were followed it would be $11{,}000 - 0.214\ (l/r)^2$.

In the specifications for the New York Connecting Ry., 20,000 lb. per sq.in. in tension, and 20,000 lb. per sq.in. in compression reduced by a column formula, were used. The net section of the members was made equal to the computed area in compression, as well as in tension. If two-thirds the above elastic limits were used, the result would be 20,000 lb. per sq.in. on the net section in tension, and $14{,}000 - 0.272\ (l/r)^2$ on the gross section in compression. This indicates disproportionately high stresses in columns on the New York Connecting Railway.

Pennsylvania R.R. Specifications Too Low

The Pennsylvania R.R. specifications prescribe 16,000 lb. per sq.in. on the net section in tension, and $\frac{16{,}000}{1 + \frac{l^2}{13{,}500\ r^2}}$ on the gross section in compression. This clearly gives values for tension members too low in proportion to the values for compression members.

The above specifications, and all others of which the writer has knowledge, give either uneconomical tension members or overloaded columns—a result that is not good engineering.

For axial stresses, it would seem that two-thirds the elastic limit should not be exceeded, but if, in bridges, secondary stresses in the plane of the truss due to deflection and rigid joints are added to the primary stresses, the sum should not exceed 24,000 lb. per sq.in. in tension and $17{,}000 - 0.33\ (l/r)^2$ in compression. In columns, it should be noted whether the secondary stress is a maximum or zero at midlength, and in both columns and tension members the stress due to the dead-weight of the member should be kept in mind. In considering the margin left for the other incomputable secondary stresses of a bending, or torsional, nature, it is well to remember that stresses on extreme fibers beyond the elastic limit do not produce proportional strains and may be beneficial rather than harmful.

Specifications for steel bridges ought to state whether or not the computed (or approximated) secondary stresses are to be included in dimensioning to the given working stresses, and the working stresses should be prescribed accordingly.

Faster-Flowing Water Does Not Mean More Water

Increasing the Rate of Flow Past a Given Point Does Not Pour More Water Upon the Stream Below

By H. M. Chittenden
Brigadier General (Ret.), United States Army

THE writer's attention was recently drawn to the subjoined statement which emanates from high engineering authority. He italicizes that portion which he proposes to use as a text for the accompanying criticism.

"If it provides for an improved channel, or otherwise for increasing the rate of flow past the point, *the result will be the pouring of more water in a given time upon the stream below* than it would otherwise have received, and a possible flooding of localities which might have escaped."

The same idea pervades nearly all the literature of the Mississippi flood problem, wherever it treats of the cutting off of bends. It is invariably considered that the shortening of distance and the acceleration of velocity, which of course would result in transporting water more quickly from the upper to the lower end of the reach affected, would bring *more* water to the lower end and thus aggravate the situation in that vicinity. This, it will be understood, is one only of the several objections urged against cutoffs on that river, but it involves the particular matter which it is here desired to consider.

Occasionally, we run across similar assumptions in foreign literature. Thus De Mas says that cutoffs tend to "bring more water in a given time to the lower portion of the valley" than would be the case without them.

In October, 1916, the writer witnessed a very dramatic presentation of the same idea, but in entirely different circumstances. It was on the occasion of the notable hearing by the Court of the Miami Conservancy District upon objections filed against the official plan of flood protection for the district. The lawyer who was conducting the case for the district—a very able man and admirably equipped for that kind of work—was cross-examining the chief witness for the opposition upon the witness's plan for making an improved channel through Dayton. This improved channel would develop higher velocities for the same volume of flow than the old channel. Acting upon the theory enunciated in our text, that this would mean the arrival of a greater volume of water at the lower end than by the old channel, counsel drew a picture of the resulting ruin and devastation in the valley below, which was truly appalling. And the force of his argument was greatly enhanced by the fact that he profoundly believed every word he was saying.

Analysis Shows Theory Is Wrong

In the face of so much and such respectable authority, it seems fairly presumptuous to pronounce the whole idea an "airy nothing" and to express amazement that it should so long have found a "local habitation" in the consciousness of the engineering profession. The trouble seems to arise from confounding velocity of flow with volume of flow and in carelessly assuming that, because an improved channel, with its higher velocity, *may* carry more water, it *must* do so under any and all circumstances. It seems incredible that so obvious a fallacy should ever have gained any standing among experts, as the above citations show that it has, and the writer can find no explanation except that just given.

The simplest analysis will show the absurdity of the whole idea. No more water can pass down a given reach of channel than enters at the head, and no amount of improvement or regulation of the channel can affect that quantity a particle. Whether it be just an ordinary channel with a coefficient of roughness of, say, 0.035, or a solid concrete channel with a coefficient of only 0.011, it will convey no more water in one case than in the other, because there is no more to convey. The water will pass through the improved channel with higher velocity, but this will be entirely offset by the smaller cross-section, and the volume arriving at the lower end per unit of time will be the same in both cases.

We have stated the rule as absolute, but there is a possible qualification, which, however, is so slight as not to affect the rule itself. We refer to differences in channel storage between the original and improved channels. If the improved channel follows the same location as the original and has therefore the same length, it will probably have somewhat greater cubic capacity, and the volume absorbed in storage with a rise in the stream will be somewhat greater. If, on the other hand, the improvement involves a cutoff and a material shortening of the channel, its cubic capacity would be diminished and there would be less water absorbed in storage. But the slightly greater quantity in one case and the slightly smaller in the other, which would flow out below, as compared with the inflow from above, would be spread over the entire period of rise, and when reduced to a second-foot basis would be practically negligible. Indeed, since all of the storage effect takes place before the flood reaches its crest, and none whatever at the crest, it would be correct to pronounce it absolutely negligible.

No Menace in Increased Velocity

But is there not a menace involved in the increase of velocity itself? This is no part of the question which we set out to consider, but it is often advanced as if it were directly connected therewith. A great deal was made of it at the Miami Conservancy hearing. Nevertheless, the "menace" is wholly inconsequential. The increment of velocity due to any practicable improvement would be at most but a few feet per second. It would be absorbed in the first few hundred feet of return to the old channel and without serious disturbance. Farther down it would have no effect whatever.

It is scarcely necessary to point out that the matter we are discussing should not be confused with the effect of cutting off valley storage. It is well recognized that the cutting off of such overflow throws a heavier burden upon the main channel in time of flood.

To return to the text of our criticism, it is submitted that there is nothing to sustain the theory that the improvement of a channel and a resulting increase of velocity mean the "pouring of more water in a given time upon the stream immediately below." For instance, if the Mississippi River were shortened, as it

might be, so that a flood entering Cairo would reach Vicksburg two days earlier than by the present channel, that fact would involve no menace if more water did not also come, which would certainly not be the case. Extensive improvements of this sort have been made upon such great European rivers as the Rhine, the Danube and the Theiss, and there seems to be no evidence that they have borne ill results in this particular respect, while their general influence has been highly beneficial.

Construction Costs Reduced by Freight Bureau

New York Highway Department Gives Contractors First-Hand Assistance in Getting Road Materials

A BUREAU to determine the quickest, shortest and cheapest routings of materials and to give an organized, authoritative and effective means of meeting the present-day car-shortage and railway-embargo problems has been established by the New York State Highway Department in the attempt to aid road building in these days of stress.

The first step necessary to place the bureau in a position to do effective work was the assembling of tariffs concerning commodities necessary in highway construction. Requisition was made on the chief of the tariff bureau of each railroad for such publications as were required. This request was stated in general terms, and as the various roads responded the tariffs were checked against the official tariff indices of the several roads, which were available in the files of the Public Service Commission, Second District.

The tariffs were filed and numbered on end in folders arranged in consecutive order in the cabinet. The arrangement was such that the tariffs of each road followed one another in alphabetical order. This makes it possible to locate quickly the tariffs of any given road in the event of an error in indexing. Future expansion was provided for without disturbing the general plan of filing.

The tariffs of each individual road are placed in the folders in numerical sequence, using the I. C. C. number where shown, or, where no I. C. C. number is given, under the P. S. C. 2, N. Y. number directly following the I. C. C. tariffs.

Card Index by Railroads

A card system is used to index class rates, demurrage, switching tariffs and exception sheets under the name of the road from or on which they apply, showing the general application, the I. C. C. or P. S. C. number as the case may be and the number of the folder in which they are located in the cabinet. Separate cards are used for each road, and in the event that one tariff covers rates from originating points on two or more roads, the tariff is cross-indexed under each of them.

The specific-commodity tariffs applying on asphalt, cement, sand, etc., are indexed under the name of the commodity. Separate cards are made for each originating road, and the application of the tariff, etc., is shown as in the case of the class-rate tariffs. General commodity tariffs are cross-indexed under both the commodities on which they apply and the name of the originating road.

At present the files contain more than 1300 tariffs and 1100 supplements. A check is maintained on the tariffs by means of a tariff bulletin issued weekly by the Public Service Commission, which insures the file being kept up to date. From information shown in the tariff publications, official classification, etc., the bureau is enabled to quote rates for the use of the engineering force in making up estimates of the cost of construction; and for the accounting department in verifying the charges assessed by the carriers on shipments where the freight is to be paid by the department.

Where No Commodity Rates Existed

In many instances no commodity rates are in effect from and to points between which it is desired to make shipments. The freight bureau in such cases takes up with the traffic officials of the interested carrier the establishing of proper rates. Rate studies are also made by means of the tariff file, and where published rates are not "in line" or are unreasonably high, the carriers are asked to reduce them to a proper basis. Reductions covering 24 individual transportations totaling $12 per net ton, have thus far been agreed to by the carriers, and are in effect.

Several instances have been noted where carriers, in their attempts to hold to their line the long haul on traffic which they originate, are moving shipments via unreasonably roundabout routes, at rates which are a burden to the traffic and which fail to maintain proper competitive relations between producing points. Some corrections of this practice have been secured and others will be taken up as occasion demands.

The work of the freight bureau has been quite seriously interfered with this season on account of the existing car shortage and the many embargoes in effect. This has necessitated considerable correspondence with the carriers and in one or two instances with the Car Service Commission of the American Railway Association, National Defense Committee. The results obtained have been quite satisfactory. The freight bureau in special instances also arranges for expeditious movement of freight through the operating departments of the various roads.

Card Index of Costs, Delivered

A card index of the delivered cost of sand and crushed stone from various sources to each point of destination in the state makes possible a comparative study of the cost of such material at any given point of destination. This index includes more than 2000 cards.

The savings effected by the bureau are tabulated to show the saving in freight charges secured through the application of the correct tariff rate; the saving in freight effected by securing material from a different source at the same price but a smaller freight rate, and the saving effected by securing from a different source at the same freight rate but at a lower price.

The freight rate bureau is managed by F. W. Brown and is under the general supervision of H. Eltinge Breed, first deputy commissioner in charge of construction, New York State Highway Department, Albany.

Modern Steel-Frame Shop Design Used in New Foundry

Steel Frame of Simple Design Well Lighted and Made Attractive by Use of Standard Finishing Materials

THE new foundry of the James A. Brady Co., Chicago, is a modern building of the shop type in which great care has been taken not only to get structural efficiency and ease of working but also to produce a pleasing appearance from the outside. It is U-shaped in plan, with a main building 266 x 143 ft. and two wings 220 x 90 ft. In the space between the wings is the material yard, served by a traveling crane whose runway is designed to carry a roof over the yard. All the buildings are of steel frame construction. A railway track is laid along the material yard. Another track runs through one of the wings and into the main building. In this way materials and heavy castings can be handled directly by the overhead cranes.

Material from Old Plant Utilized

An interesting feature is the utilization of material from the company's old plant, about a mile distant. The main building is entirely new. Both of the wings will be old steel structures. After the new main building had been completed and put in service, the old buildings were dismantled, transferred and reërected on the new site. Each of these also has its old electric overhead traveling crane. New cranes were installed in the main building and the material yard.

The main building is a good example of modern factory construction. Its 140-ft. width is made up of a high central truss span of 62 ft. 6½ in. c. to c. of columns, a side truss span of 44 ft. 6 in. and a pitched roof of 34-ft. span over the space for the ovens and cupolas. The general arrangement and structural design are shown in Fig. 1. The foundations are simple concrete footing walls and interior footings, as the buildings are only one story high and carry no great loads.

The exterior has pressed-brick walls (with terra-cotta trimming) to a height of about 6 ft., brick pilastors at the columns, and a narrow upper line of brick. The remainder of the wall space, and the entire face of the monitor roof, is of Fenestra window sash, with clear glass. This arrangement, shown in Fig. 2, insures ample light over the working floor. To prevent the accumulation of dirt on the sills at the windows, a concrete filling sloped at 45° is placed on the wall. Each window bay on the main wall has a hinged panel for ventilation, and similar openings are provided in the sides of the monitor roof. Exhaust ventilators are placed

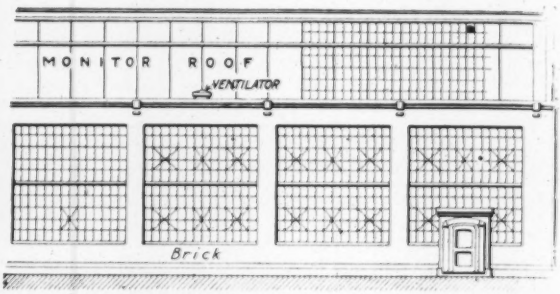


FIG. 2. NOTE THE AMOUNT OF WINDOW SPACE IN THE WALL AND ROOF OF THIS FOUNDRY BUILDING

in the lower part of the roof. The buildings are covered with composition roofing on plank sheathing. It will be noticed that the roofs slope inward to gutters which lead to drains at each end of the building.

Upper floors are required for the charging platform at the cupolas, the fanroom and the offices. These have tile and concrete ribs with a 5-in. concrete slab, supported on steel framing and columns. In the charging floor are embedded 4-in. channels, paving their flanges flush with the top of the slab. These are placed alternately 2 ft. and 3 ft. c. to c., and form depressed tracks for the wheels of the charging buggies. The office floor (9 ft. above the shop floor) has one stairway to the main entrance and another giving access to the shop. This floor is about 42 x 62 ft. and accommodates the

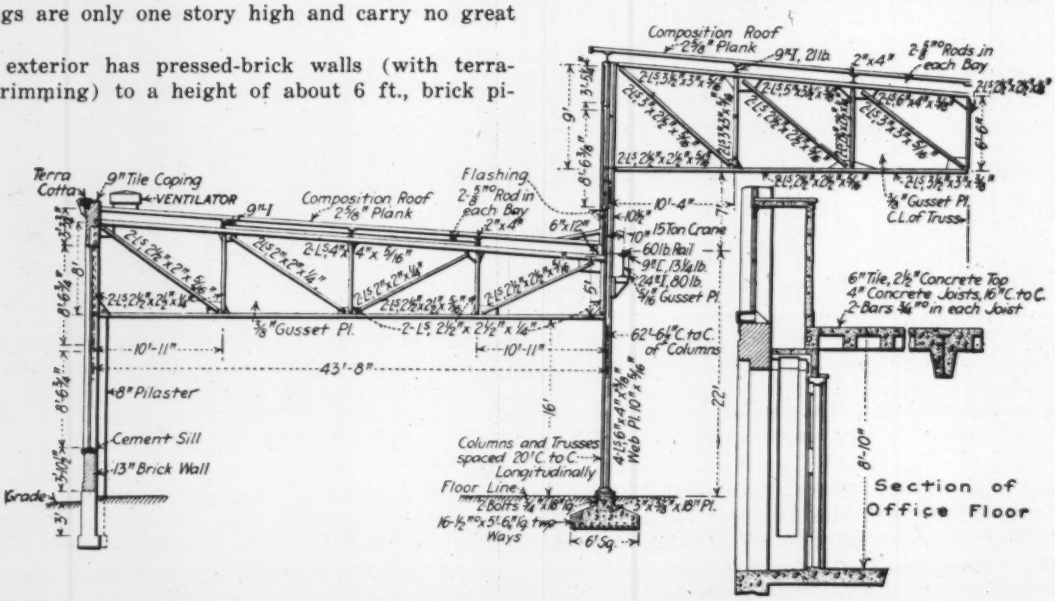


FIG. 1. STRUCTURAL DESIGN OF STEEL-FRAME FOUNDRY BUILDING

general offices, drafting roof and vault, as well as toilet facilities for the staff.

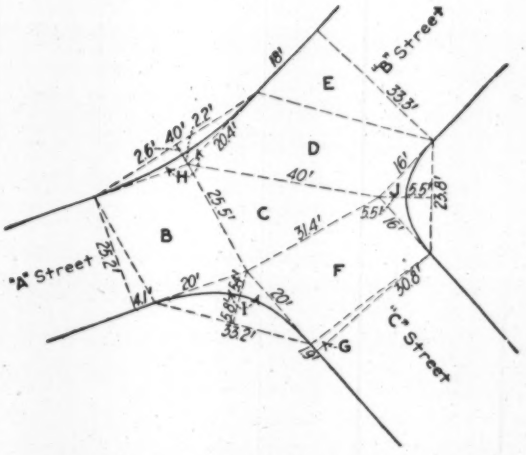
The main, or shop, floor is well supplied with toilet conveniences and drinking stands for the use of the workmen. In one corner, under the office floor, is a locker room 45 ft. square, with washing sinks and shower baths. Here also is a surgical room for first-aid in case of accident.

The appearance of the building, with pressed-brick and terra-cotta finish, might be taken to represent extra and unusual cost for buildings of this character. It is of interest to note, therefore, that by the adoption of a standard or typical architectural design for all industrial buildings the architect is enabled to purchase material in large quantities and get the benefit of wholesale prices. In this way high-class materials can be used at lower cost than cheaper materials purchased separately for each building. The architect is S. Scott Joy, of Chicago.

Irregular Street Intersection Area Calculations Simplified

By R. B. Gladding
Resident Engineer, Street Improvements, Wilson, N. C.

IT IS almost always necessary to compute the areas of some very irregular street intersections at the time of their improvement. Unless some planning is done beforehand, the proper measurements, which will result in a determination of the area with any degree of precision, are not made in the field. The accompanying diagram of a hypothetical intersection serves to illustrate

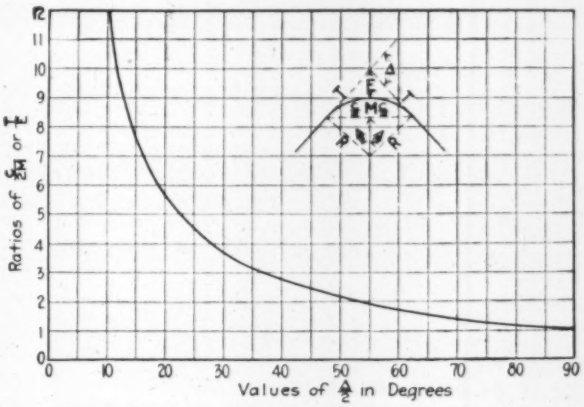


COMPUTATIONS OF AREAS OF THIS NATURE SIMPLIFIED

the use of a special curve by which the calculations are simplified, and its employment will make the fieldwork as simple as possible. Only a very brief explanation will make clear the proper procedure to follow in the field.

Let us assume that the areas of *H*, *I* and *J* are desired. While, of course, it is not exactly true that the curves at the intersection are always arcs of circles, they may be considered so for practical purposes, and very close results will be reached if proper averages are taken.

To compute these areas, the average radius and the internal angle must be determined. Since the ratio



ENTER THIS CURVE WITH AVERAGE OF LINEAR MEASUREMENT TO GET AVERAGE ANGLE

of T to E is the same as that of C to $2M$, as may be seen from the small diagram given with the curve, the one curve is all that is necessary. To determine, for instance, the area marked J, the procedure would be as follows:

$$\frac{T}{E} = \frac{16.0}{5.5} \text{ or } 2.91$$

$$\frac{C}{2M} = \frac{23.8}{11.0} \text{ or } 2.16$$

$$5.07$$

Average 2.53 equals "Ratio."

With this ratio, using the curve, $\frac{\Delta}{2} = 43°$

$$\therefore \Delta = 86°$$

Then

$$R = \frac{16.0}{tan\ 43°} = \frac{16.0}{0.933} \text{ or } 17.2$$

or

$$R = \frac{11.9}{sin\ 43°} = \frac{11.9}{0.680} \text{ or } \underline{17.5}$$

$$34.7$$

Average 17.35

Area inclosed by the tangents and the radii, 17.35 × 16.0 equals 277.5

Area of segment of circle, 86/360 × π × 17.35² equals 226.0

J 51.5 sq.ft.
5.7 sq.yd.

If the curve is considered as a parabola, the area might have been calculated in the following manner, but it does not seem at all certain that the result is as near the actual value as is obtained by the method outlined above.

$$\text{Area} = 2 \times M \times \frac{C}{4} \times \frac{2}{3}$$

$$\text{Area} = 2 \times 5.5 \times \frac{23.8}{4} \times \frac{2}{3} = 43.7 \text{ sq.ft.}$$

J = 4.85 sq.yd.

It may be seen that the first method is more likely to give a better result than the one based upon the curve being a parabola, because more measurements are utilized. However, either assumption will simplify the computation over the usual method.

Serious Fuel-Oil Situation May Affect Many Industries

Conservation of Oil Resources Now a Vital Need—Committee Outlines Plan and Appeals for Government Aid

A REPORT has just been completed by the committee recently appointed by Governor Stephens of California to make an investigation of the petroleum resources of that state, with particular regard to the industrial and military needs of state and nation in the present war emergency. The committee found that the oil production in California (whence comes one-third the entire supply of the United States and about one-quarter of the world's supply) is falling behind consumption at the rate of 35,860 bbl. per day. This excess of consumption over production is now being taken from oil in storage, and at the present rate the storage in California will be reduced to the 10,000,000-bbl. safety margin by Sept. 20, 1918. Should consumption increase or production decrease, both of which are likely unless immediate action is taken, the safety margin will be reached at an earlier date.

The seriousness of the situation is emphasized by the fact that considerable time is required to adapt power equipment for other sources of energy. It is pointed out in the report that fuel oil is largely used in the operation of the steam railroads of the Western States, the Panama Canal, steamship lines, cement plants, mines and smelters, gas plants, sugar refineries and, in general, a substantial portion of the manufacturing, industrial and agricultural enterprises of the Western States.

Consumption Exceeds Production

The oil production in California has not been increasing in recent years. In 1914 it was 103,620,000 bbl.; in 1915 it was 89,570,000 bbl.; and in 1916 it was 91,820,000 bbl. The production in 1917, indicated by the present conditions, would be about the same as last year. The report points out, moreover, that further substantial increases in the annual petroleum production cannot be expected through the discovery of new fields or large extensions of existing fields.

Throughout 1916 the consumption exceeded the production by an average of 1,100,000 bbl. per month, or 36,650 bbl. per day. During the first five months of 1917, consumption exceeded production by 5,415,000 bbl., or 35,860 bbl. per day. Of course, the storage has been reduced correspondingly. Although the total remaining storage on July 1, 1917, is reported to have been about 38,000,000 bbl., this would be reduced to a much lower figure if limited to available fuel oil, because a considerable percentage is light oil, is below tank outlets or is otherwise unavailable. The stored oil is owned principally by the Standard and Union oil companies.

The substitution of coal for fuel oil was considered in the investigation, and the conversion of steam railroads from oil to coal burners in regions adjacent to coal fields is touched upon in the report. However, apart from the changes already made or contemplated, there is little possibility of further conversion from oil to coal during the war, unless the conditions surrounding the production and transportation of coal materially change.

The substitution of hydro-electric energy has already taken place to a considerable extent in industrial and agricultural uses, but this has been hampered by difficulty in securing copper and other material and also by the disturbance of existing conditions that would be entailed by diverting large blocks of hydro-electric energy to service previously rendered by oil-burning plants. Large additional oil saving through the substitution of hydro-electric energy cannot be expected during the war, the report states; but after the war and the restoration of normal industrial conditions, wherever hydro-electric energy is available it will play an increasingly important part as a substitute for the fuel. Meantime, interconnecting the transmission systems of electric companies is suggested as a means of eliminating or at least reducing the necessity of maintaining steam-electric plants.

Relief Measures

The difficulties standing in the way of prompt and substantial increase of production must be quickly removed, the report states, if a serious industrial crisis is to be forestalled. The emergency cannot be met without the assistance of the Federal Government, and the report urged that California state officials make direct appeal to the administration at Washington.

While it is believed possible to increase production more than 30,000 bbl. per day, this increase cannot reasonably be expected to be available before June 1, 1918. To secure the best and most immediate results the committee recommends:

1. That production be increased immediately by additional drilling on the lands which can be developed in the least time with the smallest expenditure of material and labor.

2. That every effort be made to reduce field losses, to encourage the highest use of petroleum and its products and the substitution of other forms of fuel or power where possible.

3. That the Federal Government be promptly advised of the situation and asked to render every assistance possible.

4. That manufacturers of oil-well supplies and the railroads be directed to expedite the production and transportation of oil-well casing, drill stems, wire cables and similar material—bringing the influence of the Federal Government to bear, if necessary.

5. That all skilled workmen in the oil fields be exempted from military service.

6. That lands in litigation be developed either through the Federal receivers or through the claimants to the lands, with due regard to the rights of all parties. (In this connection it is notable that 70% of the desirable undrilled lands are involved in litigation with the Federal Government.)

7. That additional lands be thrown open for development by the Federal Government.

8. That steps be taken immediately to correlate the transportation facilities of the railroad, steamship, oil-pipe and oil companies, that transportation may be expedited, and

9. That as far as possible the burning of unrefined petroleum be prohibited.

The committee, which is officially known as the Committee on Petroleum of the State Council of Defense, consists of Max Thelen, president of the California Railroad Commission; Eliot Blackwelder, professor of geology, University of Illinois; and David M. Folsom, professor of mining engineering, Leland Stanford, Jr., University. The preliminary outline of the committee's report was telegraphed to Washington on July 7 by Governor Stephens, and a prompt acknowledgment was received by wire signed by President Wilson, expressing appreciation of the importance of the work and promising Federal support for the general plan.

Iowa's Traffic Census Includes Weight

A unique traffic census is being taken in Iowa. It includes actual weighing of vehicles on a farm scale set up over one-half the roadway. The purpose, according to the *Service Bulletin* of the Highway Commission, is to secure accurate data upon the number of vehicles using the roads; upon the relative proportions of travel between farm market traffic; the traffic between towns, classed as interurban traffic and tourist traffic; the relation between motor vehicles and team traffic; the character of the tires in use, and the actual tonnage transported. Ten-day tests will be made on important roads and will continue for three months. The relative importance of various roads, the amount of traffic roads of various characters will carry in varying types of weather and the proportions of various kinds are sought. Some indication will be adduced as to the apportionment of expense of first cost and maintenance to local, township, county, state and Federal agencies.

Six Months Allowed To Erect Large Concrete Warehouse

Five-Story Warehouse and Freight Station Covering Three Acres, Started in March, To Be Finished Next September

RAPID construction is a prominent feature of the $1,500,000 freight station and warehouse now being built for the Central Manufacturing District, of Chicago. The contract was let Mar. 1, 1917, and called for completion by Sept. 1. For this reason, the equipment and layout of the construction plant were worked out by the architects and the contractor in consultation, and certain structural features were designed to facilitate the arrangement of this plant and the carrying on of the work. S. Scott Joy is architect for the District, with John L. McConnell as assistant architect. The contractor is E. W. Sproul. Fig. 1 shows work in progress on June 1 and gives an idea of the size of the building.

Floors Are Flat-Slab Type

The building is 590 x 240 ft. It has a basement for machinery, a freight station on the first floor and five warehouse floors leased to Montgomery Ward & Co. It is divided into four units or blocks, 125 ft. wide, by transverse 30-ft. light courts, but the units are connected by bridges at the center line of the building. This is shown by Fig. 2. The design is of reinforced-concrete throughout, with floors of the flat-slab type. The walls are of pressed brick with terra-cotta trimmings.

The concreting outfit is the principal feature of the plant, and its arrangement is shown in Figs. 2 and 3. Sand and stone are brought in by bottom-dump railway cars on a track on the first-floor level, the materials being dumped into bins in the basement. The storage capacity here is 400 yd. of stone and 200 yd. of sand. Excess material is stored in stockpiles in the open yard (as much as 75,000 yd. at times) and loaded into cars as required (for transfer to the bins) by a derrick car with grab bucket. Cement (in sacks) is delivered by cars and is stored in a shed on the first floor.

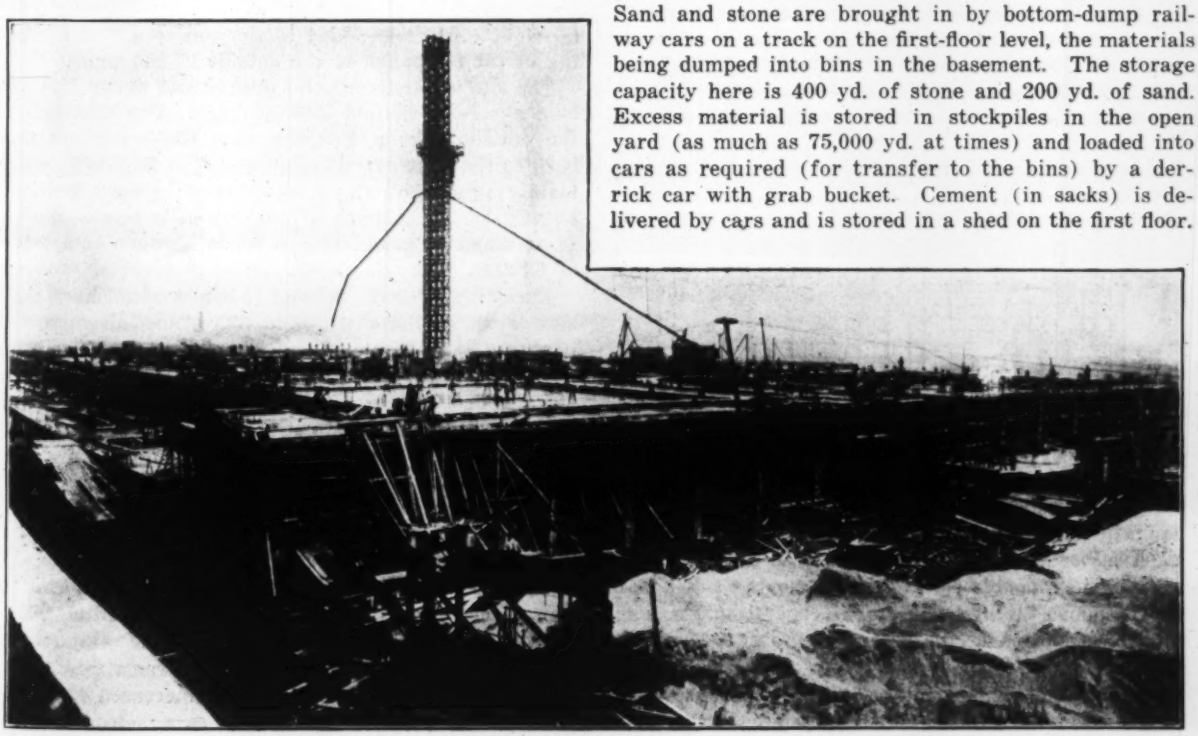


FIG. 1. CONCRETING THIS HUGE WAREHOUSE IS DONE BY SPOUTING FROM DOUBLE ELEVATOR TOWER TO FLOOR HOPPERS AND BUGGIES

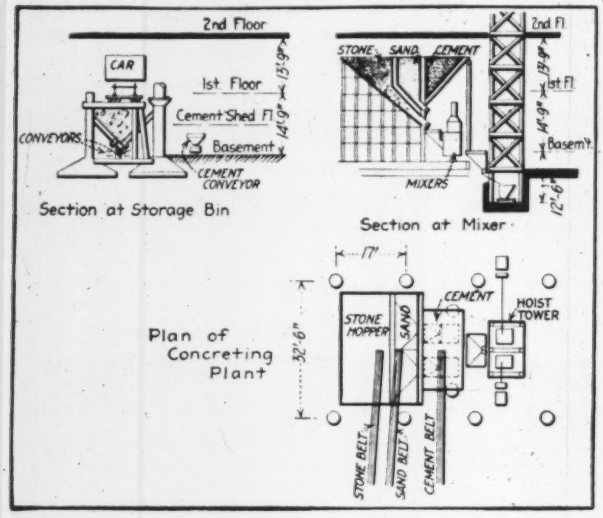


FIG. 2. ELEVATION AND PLAN OF CONCRETING PLANT

Two parallel 36-in. belt conveyors, 150 ft. long, extend under the bins, one for stone and the other for sand. Their ends are inclined so as to deliver the materials to the 50-yd. feed hoppers just below the second-floor level (Fig. 3). A third conveyor (on the first floor) extends from the concrete shed to a third feed hopper. The bags are opened at the shed and the cement dumped through a hopper onto the belt. The conveyor is inclosed to protect the cement from the weather.

From the three feed hoppers the materials are fed to an automatic measuring hopper. This discharges the

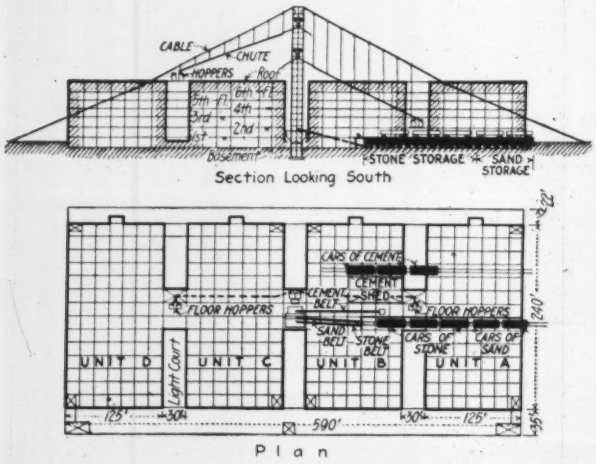


FIG. 3. ARRANGEMENT OF CONVEYORS AND HOPPERS TO SERVE PLANT WITH TWO CONCRETE MIXERS

batch into two 1-yd. Milwaukee mixers in the basement. Each mixer delivers the concrete into a 1-yd. bucket working in a double elevator tower having a height of 185 ft. above the first floor. The concreting plant and tower are located at the center of the site, as shown. Cables from the top of the tower carry two lines of steel spouting. This spouting and the concrete hoppers in the tower were raised as the work progressed. This plant makes and places from 900 to 1000 yd. of concrete per day.

The spouts deliver to two floor hoppers, from which the concrete is discharged through gates into ½-yd. wheeled carts or buggies. For some of the outlying work there are two small (½-yd.) portable mixers (one steam and one gasoline), as it does not pay to haul the concrete far in the buggies. These mixers were used also for the footings and other parts of the earlier work before the installation of the main plant.

All form work is of wood, except that sheet steel is used for the column forms. In order to enable the second floor to be built before the first floor was hard enough to carry shoring, the upper forms were supported on wood trusses seated on the concrete beams between the columns. This detail is shown in Fig. 4. A wood-working shop and bar-bending outfit facilitate the work.

The concrete is a 1:2:4 mix, except that for the lower columns it is 1:1:2. To make the basement wa-

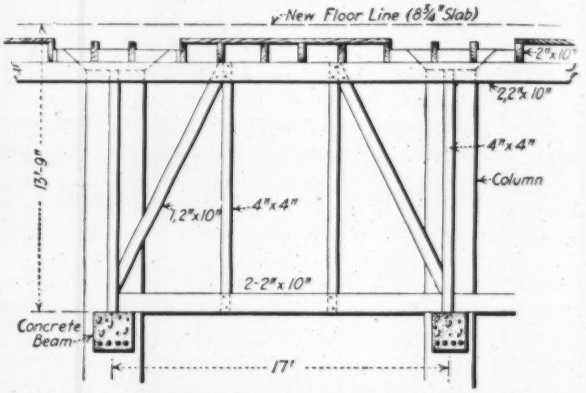


FIG. 4. FORMS OF UPPER FLOOR ARE CARRIED BY TRUSSES SEATED ON CONCRETE BEAMS

ter-tight Ceresit is added to the concrete, and a coating of tar is applied to the outside of the walls.

The site is partly on solid ground and partly on filled land alongside the old Bubbly creek. For this reason the outside column footings near the creek are tied back to the next row of columns. The foundations are mainly groups of Raymond concrete piles. For the heavily loaded columns of the tower, concrete piers 4 ft. in diameter are carried down to hardpan at a depth of 50 feet.

Excavating for the column footings would have been slow work, so the entire area was graded down to the basement level by steam shovels. This enabled part of the space below the first floor to be utilized for the storage of concrete materials and for the concreting plant, as described. Later the space up to the first-floor level (except the basement for machinery, etc.) will be filled with sand brought in by trains.

The Automobile and Roadbuilding

In 1916 there were 3,513,000 automobiles and 251,000 motorcycles registered in this country, according to the United States Office of Public Roads. The revenue they yielded in the form of licenses and registration fees was $25,865,000. The revenue had increased 42% over that for 1915, and the number of cars and motorcycles had increased 43%. About 92% of the revenue was spent on road improvements of some kind.

Dewatering Activated Sludge at Urbana Sewage Station

Rotary Filter and Specially Designed Centrifuge Among Devices Tried—Centrifuge Gave 88% Moisture Sludge

MANY DEVICES for dewatering sludge produced in the activated-sludge experiments conducted at the Sewage Experiment Station of the Illinois State Water Survey at the University of Illinois have been tested. A review of the tests was given in a paper by Prof. Edward Bartow, director of the survey, read last June before the American Institute of Chemical Engineers, at Buffalo, New York.

Drying on sand beds proved unsuccessful, even when the beds were constructed with great care and covered with canvas on a frame as protection against rain. A filter press with leaves 8½ in. square has not given a cake of good consistency, but is being tested further.

Rotary Filter with Filtros Plates

A rotary filter was tested. This is described in the paper as follows:

"Through the courtesy of the Koering Cyaniding Co., Detroit, a rotary filter was placed at our disposal. This style of filter is used satisfactorily in filtering slimes in extracting gold and silver by the cyaniding process. The apparatus consists of a cylinder of filtros plates supported on a perforated steel cylinder, outside of which at a distance of about 1 in. is a solid-steel outer shell. The material to be filtered is forced into the interior of the cylinder of filtros plates, the cylinder is revolved, and a cake of sludge is built up on the inside of the plates. The liquid filters through the plates into the space between the cylinders. Air pressure can be exerted from the interior to dry the cake, and from the exterior to loosen it. The plates can be cleaned by back-flushing with water. The first trial with a comparatively heavy and not very fresh sludge did not give satisfactory results. The quick-opening door could not stand the pressure. Another trial will be given as soon as the door can be replaced."

Specially Designed Centrifuge

Various centrifuges of basket and bowl types were tested. The description of one of these follows:

"A specially designed centrifuge was purchased from the Tolhurst Machine Works, of Troy, N. Y. This machine is 12 in. in diameter, 9½ in. high and at a speed of 1800 r.p.m. exerts a centrifugal force of 550 lb. The machine can be filled in 12 min., using sludge of about 99% moisture. Approximately 25 gal. of the sludge are added and 10 lb. of sludge cake obtained. The sludge cake contains about 88% moisture. The space underneath the rim contains 0.158 cu.ft. Owing to the small size of the machine and to the fact that the material must be scraped out, the time of cleaning is longer than would be required for a larger machine with an opening in the bottom, so that a large machine could undoubtedly have been filled and emptied more rapidly than the small laboratory machine.

"We have found it entirely possible to fill and empty the small machine twice in one hour. Calculating that the same rate could be used with a 40-in. machine having 46 times the capacity, we could obtain in each filling 460 lb. of sludge of 88% moisture, equivalent of 55 lb. of dry material. One 40-in. machine would, therefore, deliver the equivalent of 1100 lb. of dry material in a working day of 10 hours. On the supposition that one-half ton of dry material will be obtained from 1,000,000 gal. of sewage, one machine would easily dewater the sludge from 1,000,000 gal. of sewage per day. The cost of the 40-in. machine at present is only $750, and the power to run it is small enough to make the process appear practical for preparing sludge cake for a drier.

"The actual cost of dewatering will depend upon the amount of water that can be removed by the centrifuge, the size of drier and the amount of coal required for removing the residual water. It is hoped that these figures will be available in the near future."

Filtros Plates Made Best Showing in Air-Diffuser Tests

Competitors Were Basswood Plates and Perforated Pipe—Tests by Illinois State Water Survey at Urbana

PARALLEL tests of air diffusers for the activated-sludge process of sewage treatment have been made at the Sewage Experiment Station of the Illinois State Water Survey at the University of Illinois and were reported at the Buffalo meeting of the American Institute of Chemical Engineers, June 20, by Prof. Edward Bartow, director of the survey. The tests were made in four concrete activated-sludge tanks, each 3 ft. 2 in. square and 8 ft. deep, having a capacity of 350 gal. of sewage per filling.

In the bottom of each of two of the tanks were placed three filtros plates. In one tank the filtros plates were rated as "fine," and in the other they were rated as "coarse." The fine plates on a dry rating passed 5.8 cu.ft. of air per minute per square foot under a water pressure of 2 in., and the coarse plates under the same conditions passed 12 cu.ft. The wooden blocks were ½ in. thick, 6 in. long and 2¼ in. wide. These blocks filled a space 1 ft. $3\frac{9}{16}$ in. by 2 ft. 3 in. in plan, the blocks being set in a cast-iron frame so shaped that the blocks were on a curve, so that in swelling they would wedge themselves more firmly into position. The pipe diffuser had perforations $\frac{1}{25}$ in. in diameter, 2 in. apart, set at an angle of 45° from the top of the pipe. There were about 40 holes in the pipe grid, or four per square foot of surface area.

The tanks were operated during three periods of 15, 20 and 35 days. The air was measured by gas meters, the same amount of air was delivered to each tank and all the other conditions were maintained as nearly identical as possible. The tests are thus summarized by Professor Bartow: "The results obtained from these comparative tests indicate the superiority of filtros plates and air diffusers over perforated pipes such as were used in our tests under the conditions mentioned. The wooden blocks were difficult to handle, though this was caused in part by the faulty design of our containers. Even in the time they were used there was

evidence of considerable deterioration. From the results obtained we could distinguish little, if any, difference between the coarse and fine grades of filtros plates. With air free from dust and oil, there should be little trouble experienced from clogging of plates."

From sources outside the paper by Professor Bartow we learn that the wood plates latterly used at Milwaukee by Carl H. Nordell in tests carried out by him under the direction of T. Chalkley Hatton were creosoted, and that this and other improvements obviated some of the difficulties experienced at Urbana.

Convict Labor Proves Effective on California Roads

Difficult Construction in Rough Territory Done at Low Cost—Camps Increased to 100 Men Without Armed Guards

CONVICT LABOR has been entirely successful in California, according to Charles F. Stern, state highway commissioner, who, in an address before the League of California Municipalities, recently described the work being done. It has taken some time to effect the necessary legislation and try out the various means of carrying out the idea, stated Mr. Stern, but the system as now in use is believed to be as effective as could be desired.

At the outset there was a division of opinion as to whether the honor system or armed guard should be adopted. The honor system was finally decided upon, and the first camp established in Mendocino County in 1915 had only three representatives of the prison authorities, all unarmed. This camp was described in the *Engineering Record* of Feb. 19, 1916. After the success of this first unit was demonstrated, the camp was increased to 100 men.

A 33-mile section of mountain road has just been opened to traffic in the northern part of Mendocino County. The work on this section was extremely difficult, and the engineers' estimates on cost ranged from $335,000 to $400,000. The actual cost of constructing it by convict labor was about $200,000, and it was completed in two years' less time than was considered feasible under any other system.

In the course of this work about 200,000 cu.yd. of material, averaging more than 50% rock, was moved at a cost of about 40c. per cu.yd. This is little more than half what similar work has cost under contract in the same locality. Included in these cost figures are all items of expense incidental to employing convict labor, such as supplying the men with clothing, transportation, food, camp equipment and medical attention.

Since this first camp was established in the northern part of the state, four others have been opened on difficult roadwork in the Sierra Nevadas. The men are practically free of restraint and are treated on and off duty like free men. Mr. Stern believes that "unquestionably this system, sanely and sympathetically handled, means the building of many hundreds of miles of roads that could not otherwise be built, at a saving of many thousands of dollars in the cost of construction."

Imperfect Washing of Filter Causes Aftergrowths

The Exact Reason for This Action Is Not Certain but Indications Point to Accumulation of Sand in the Underdrains

AFTERGROWTHS in the Akron (Ohio) filters were caused by an abnormal growth of crustaceans which the filters could not remove entirely. They were also entangled in the alum "floc" and were carried to the bottom of the coagulating basins, where they died and formed a food supply for bacteria. The same condition existed in the filters. "An examination," says J. S. Gettrust, chemist, in the last annual report of the Water Department, "showed that all the Crustacea were not removed by the washing process and that some of them became attached to the sand grains and remained in the sand bed, where the bacteria thrived on the food supplied by their bodies. By the use of liquid chlorine the bacteria in the filtered water were easily reduced in numbers so that a very good effluent was obtained.

With regard to the filter underdrain efficiency, he states as follows:

Laborers May Have Disturbed Gravel

"In the corners and in some places along the sides of the filters the sand does not wash perfectly and there is a tendency for it to pile up at these places. The exact cause of this imperfect washing has not been determined. It may be caused by sand in the underdrains, which has been washed to the corners of the underdrains during the washing process. The gravel layer may have been disturbed by the laborers in walking over the gravel at the time it was put in place. The gravel may have been disturbed by accumulations of air in the filters which, if forced through the gravel during the washing process, could destroy its even distribution. In the operation of the plant every precaution has been taken to avoid this. The displacement of the gravel would allow sand to work down into the underdrains. The concrete ledge around the sides of the filters, which is formed by the top of the pyramids, may have a tendency to cause this behavior of the sand along the sides and in the corners. If the wash water is not applied with a uniform pressure under the openings in the pyramids, there would be a tendency for the sand to behave as has been observed in the filters.

"The hydraulic valve on the wash-water line, which operated automatically to maintain a constant pressure in the wash-water supply to the filters, gave trouble during the first part of the year. The use of this automatic arrangement was discontinued and the pressure of the wash water to the filters was controlled by throttling a bypass valve around the automatic valve. This arrangement gives very satisfactory results."

Results of the operation of the filter reduced the bacterial count from 1827 in the raw water to 34 in the effluent, but it was observed during the year that there was a great difference in the sanitary quality of the water from certain taps in the city. Investigation pointed to contamination from industrial connections. This was prevented by placing duplicate check valves on the factory side of the meter.

Concrete Dam 17 Feet High Has Automatic Flood Gates

Concrete for Cedar River Structure at Nashua, Iowa Placed in Cofferdam from Trestle—Floods Complicate Work

By C. W. Older
Superintendent of Construction

IN BUILDING a 17-ft. concrete dam for a hydro-electric plant on the Cedar River at Nashua, Iowa, some interesting construction methods were employed. The dam is equipped with a number of automatic flood gates,

DAM AT NASHUA, IOWA, HAS 7 x 46-FT. FLOOD GATES

or movable dams, each 46 ft. long and holding back a maximum of 7 ft. of water.

The contract was let and work commenced when the spring floods subsided sufficiently to start the cofferdam. This was hand construction, built out from the shore. The filling followed close to the sheeting progress, so it was secured at all times against accident by high water.

Difficult To Keep Water from Cofferdam

The condition at the bottom of the river was such that it made it very difficult to keep the water out of the cofferdam. Boulders and gravel covered the river bed, and the distance to bedrock below the river bed varied from 4 to 20 ft., sloping from both banks to mid-channel. This condition could not be determined before excavation, as all testing rods stopped on boulders or shattered ledges at about the same elevation. When bedrock was uncovered, it was found to contain fissures through which flowed "well water" that was taken care of with pumps. This broken ledge had to be penetrated to the solid rock and a heavy footing of concrete built.

In locating the cofferdam, it was necessary to find a natural cutoff, as on a sand bar. Then by putting in a well-ballasted crib, all water was shut out except that which came in through the rock ledge. The ballast was essential, as Cedar River is subject to frequent floods; and at such times the current is very swift.

When the floods subsided, the undamaged cofferdam was still there and only required pumping out to allow operations to continue. When bedrock was exposed, it remained to wash and wire-brush it thoroughly to allow a perfect adhesion with the concrete. Because of the "well water," tile weepers were installed where the veins were the largest, to prevent possible heave. A thin layer of grout was spread over the rock and worked well into all irregularities before the regular concrete was put in. This made a first-class water seal, which subsequent tests proved to be perfectly satisfactory.

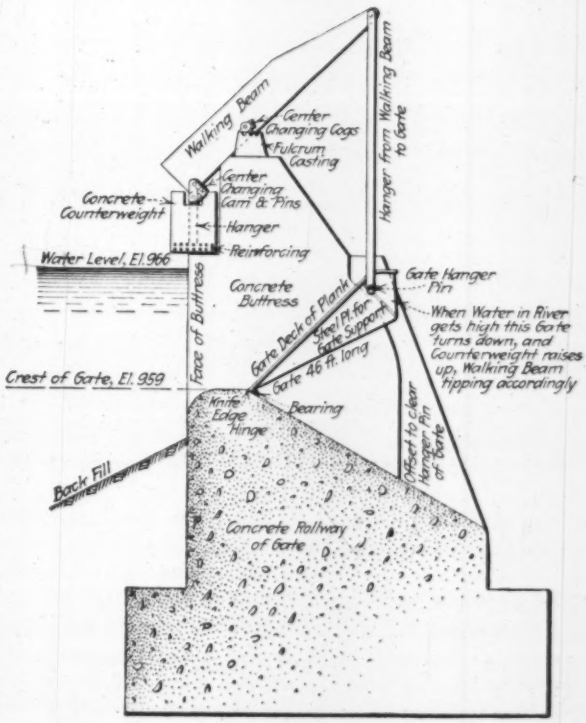
Concrete Placed from Trestle

The concrete was all placed by the trestle system. The mixer was installed on the bank and a double-track trestle built to reach all parts of the job. An endless cable, on a hoisting drum, was run continually. Each concrete car was provided with a grip and brake. An operator rode with each car; and as the mixer dumped directly into it, there was no time lost, for a car was always in readiness to take the batch as soon as mixed. Chutes were hung to the trestle wherever required, so very little labor was needed in placing. Large "keys" were left in the top of each run, and in each key anchor rods were inserted for safety.

The footings did not require much formwork, a curb on the downstream side being sufficient. The concrete upstream ran directly into the rock. The downstream side was cut down with a clearance of 35 ft. to provide for a concrete apron 3 ft. thick, to prevent wash by the water over the flood gates. This apron was then loaded with large rocks up to the natural river bed. It was also provided with weepers at frequent intervals.

In the rollway section, the exterior shoring was not used to any great extent, but the forms were well tied together with No. 8 black wire attached to wales on the outside. By turning these up against a gage stick, the form, when full, held to an exact line.

Because of possible floods, the amount of exposed form was always kept as small as possible. This was


Walking Beam
Center Changing Cogs
Fulcrum Casting
Center Changing Cam & Pins
Hanger
Reinforcing
Concrete Counterweight
Hanger from Walking Beam to Gate
Water Level, El. 966
Concrete Buttress
Face of Buttress
Gate Hanger Pin
When Water in River gets high this Gate turns down, and Counterweight raises up, Walking Beam tipping accordingly
Gate Deck of Plank
Steel Pt. for Gate Support
Gate 46 ft. long
Crest of Gate, El. 959
Knife Edge Hinge Bearing
Offset to clear Hanger Pin of Gate
Back Fill
Concrete Rollway of Gate

WALKING-BEAM AND COUNTERWEIGHT RAISE FLOOD GATE WHEN RIVER FALLS

accomplished by building the dam mostly in vertical sections. Expansion joints were allowed between some of these, with an ingot-iron cutoff. The joints were filled with ¼-in. fiber, which was applied with an adhesive paste. The fresh concrete running to this made a water-tight expansion joint. About two-thirds of the dam was built in this way, leaving the rest of the channel open for the river.

To build the remaining part of the dam required diverting the river. For this purpose temporary openings were left in the rollway. These were later cut off with stop-logs and filled with concrete, which was accomplished with very little difficulty. Bearing strips for these logs were bolted to the upstream side and built out 2 ft., with a concrete sill 2½ ft. wide at the bottom of the opening on which to rest the stop-logs. This made the clearance between the stop-logs and concrete line ample for the form and wales. These were backed up with sand, making them nearly water-tight. Pipe weepers were inserted in the bottom, which took care of the seepage, the pipe entrance being between the form and the stop-logs. After the form was filled, a few batches of concrete dropped into this interval shut it off completely.

Design and Installation of Flood Gates

The installation of the flood gate is worthy of comment, because this particular type is new to this country. It was imported from Switzerland by the Fargo Engineering Co., and service has already proved its value. It is simply a walking-beam with a gate hung at one end and a concrete counterweight hung at the other. The gate is hinged at the bottom. When the water rises above the required elevation, the gate turns down, which in turn raises the counterweight. The higher the water the farther it opens the gate. When the gate opens, the leverage between the counterweight and fulcrum increases and that between the gate hinges and fulcrum decreases, thereby overcoming the increased weight of water at every stage of gate opening. Gravity and constantly shifting leverage are its features. The gate is of steel and was entirely fabricated and set before grouting in.

To prevent freezing during construction (the weather being cold), a double form was used and live steam turned in through a pipe, the whole being covered with straw. Setting this concrete with live steam made it extra solid, so a stone-dressing tool made slow impression on it.

Leather Bearings Prevent Leakage

Creosoted plank was used for decking, well bolted on. Leaking around the ends was prevented by a leather bearing on the concrete. A leather bearing on a curved plate prevented leakage over the hinge where the gate fastened to the rollway.

The counterweight was formed and poured in place, being shored up from the crest of the dam.

The power house is built into the dam at one end. It contains four waterwheels, each directly connected to a horizontal generator developing about 900 horsepower.

The building of the power house required much solid rock excavation, some of which had to go deep to provide for the draft tubes. These required large horn-shaped forms, which were made of segments with 1 x ½-in. strips attached securely and as regularly as possible. The whole was then covered with sheet iron to give a smooth surface to the inside of the finished tube. The forms were built on shore and hauled down with a large stoneboat. They were hoisted into place with a gin pole, then shored, weighted and concreted. The penstock walls were then set on the foundation. When this was done, the wheels were set on the top of the draft tube and grouted in. The main floor that supports the generators is composed of beams and panels of reinforced concrete, with a maximum thickness of 2½ ft.

The dam was built by the H. A. Maine Co., Waterloo, Iowa, for the Cedar Valley Electric Co., Charles City, Iowa.

Approximate Methods Desirable for Arch Design

Properly Applied, It Is Contended That They Will Give Results Conforming Closely to Full Elastic Analysis

By Joel B. Cox
County Engineer, Wailuku, Maui, T. H.

THE elastic theory when applied to arches with fixed ends is not only time-consuming, but is essentially a method of analysis and not directly of design. Hence there is a real need for satisfactory formulas or methods for determining approximately the crown thickness and the proper form of the arch ring. It is necessary in order to determine the stresses to assume the dimensions of the arch rib. Experience must be the main guide in this primary assumption, and the designer has two classes of aids:

1. *Empirical formulas*, which are crystallized expressions of past experience;

2. *Approximate methods*, by which crown thrusts and lines of pressure may be determined.

Formulas of the first class are the modern representatives of the experimental proportions which probably guided the ancient arch builders. Methods of the second class are an outgrowth of the line of pressure theories developed for voussoir arches, and are an improvement over class 1, principally in that a greater range of conditions can be considered, and that more particulars of the form of the arch can be determined by their use.

Procedure in Design of Arch Ring

In the *Engineering News* of Nov. 9, 1916, page 880, Joseph P. Schwada presents formulas for the thrust T and the depth d at the crown in terms of a coefficient K representing the ratio between the average crown stress and the maximum stress in the arch. The writer has derived the following equation for the thrust, based upon the assumptions used by Mr. Schwada, but using the general formulas derived by C. Tourtay in 1902. In Mr. Schwada's notation:

$$T = \frac{L^2}{R - d}\left(\frac{B + w}{8} + 2.28R + 17.61d + 15F\right)$$

This equation gives slightly lower values than Mr. Schwada's equation, all terms being identical except

those in the parenthesis containing R and d. The depth at crown is

$$d = \frac{T}{144 f_c K}$$

Mr. Schwada presents a valuable series of diagrams and tables for the value of the coefficient K, and for the solution of his equations.

The process of the design of an arch ring is then as follows:

1. Tabulate the general conditions which can be at once determined or assumed, and the known factors such as span, rise, loads, etc.
2. Make a rough assumption of the crown and springing line thickness (possibly using a formula of class 1).
3. Compute the value of thrust T, and if necessary correct the assumed crown thickness.
4. Construct a line of pressure with horizontal thrust (pole distance in the force polygon) equal to T.
5. Choose a value for K which will suit the type, the rise, and the span of the arch, and compute the value of the crown thickness d.
6. Choose a curve for the arch axis which will fit the line of pressure constructed as in 4.
7. Vary the thickness of the arch and place the reinforcement in accordance with the thrusts shown in the force diagram, but making proper allowance for the effects of moving loads and temperature.
8. Analyze the arch thus determined by the elastic method.

It will be found that a very close approximation to the best design is determined by the first seven steps, and only minor changes may be expected from the full elastic analysis, while the labor is far less than a preliminary analysis by the elastic method.

In this way, although the elastic analysis of concrete and reinforced-concrete arches is usually assumed to be the only satisfactory basis for design, and so may be thought to have superseded the older methods of formulas and lines of pressure, the very fact of its growing use has called for a revival and improvement of the approximate methods as aids and time savers to be used in conjunction with the modern analysis.

Sanitary Patrolmen in Cleveland

Since July 1, Cleveland, Ohio, has had 25 patrolmen at $1400 a year and a sergeant at $1500 a year engaged in sanitary-patrol duty. The charge is to be against the Police Department appropriation. This will be a continuation of work started in September, 1916, by the Health Department, which since that date has employed eight sanitary patrolmen acting under a sergeant (the latter assigned from the police force). These nine men were put to work in the most congested sections of the city, specializing on alley conditions and giving particular attention to the installation of receptacles for garbage. Up to June 1, garbage receptacles with a total capacity of 316,810 gal. were installed, or receptacles for 31,681 families. In addition, 734 manure boxes were removed to the premises of the owners and made fly-tight with good covers. The work thus far has covered an area of about 10 square miles. With the increased force on July 1, it is expected to expand the service rapidly.

SOCIETY SERVICE

A Section Dealing with the Results of Teamwork by Technical Men

How the Classification of Engineers Was Done in Rhode Island

Robert W. Adams, president of the Providence Engineering Society, contributes the following live account of the classification of engineers in Rhode Island:

Early in the year, when it became evident that suitable provisions should be made for the mobilization of all resources which could be used to advantage for the preservation of our welfare, a group of public-spirited citizens called together at the order of Governor Beekman organized the Rhode Island Committee of Public Safety, Feb. 23, 1917. The officers of the Providence Engineering Society had previously recognized the important assistance that the engineers could render in any crisis and had volunteered its services to the governor; as a result the writer was appointed a member of the Public Safety Committee. A classification of engineers throughout the state, according to special qualifications for either military or auxiliary civilian work was at once undertaken.

For a list of engineers, the mailing list and prospect list of the Providence Engineering Society were used as a basis. This list was enlarged by consultation with public service corporations and other organizations, so that the final result was a list of over 900 names of men connected with engineering work throughout the state.

To these men were mailed classification blanks, together with a suitable explanatory letter and a stamped return envelope. Over 500 replies were returned properly filled out, indicating a very general interest and willingness to be of service. The replies were tabulated as below, (1) in accordance with the enrollment blank for commissions in the Engineer Officers' Reserve Corps, and (2) by special qualifications. The duplications in the second list are due to the fact that the training of nearly every engineer includes certain fundamentals, such as drafting and familiarity with machine work.

GENERAL CLASSIFICATION	
Bridge engineer	37
Constructing engineer (A)	109
Constructing engineer (B)	98
Electrical engineer	82
Highway engineer	65
Mining engineer	11
Railroad engineer	37
Railroad operating official	5
Sanitary engineer	36
Topographical engineer	51
	531

SPECIAL QUALIFICATIONS	
Airplanes	6
Chemistry	54
Drafting	209
Foundry	38
Gas and gasoline engines	79
Hydraulics	63
Illumination	52
Machine shop	194
Naval construction	8
Power-boat operation	57
Pumps and pumping engines	73
Structural iron	44
Telegraphy	7
Telephony	23
Use of explosives	20
Wireless telegraphy	13
	940

The original classification blanks have been bound in alphabetical order for future reference and the committee now has at its disposal very complete information with reference to the engineering resources of the state, while in addition the Providence Engineering Society has available a great deal of data with reference

to engineers which will enable it to arrange its future program so as to be of the greatest value and interest to the engineers within its influence.

It has been particularly interesting to note the engineers of remarkable talent and experience in certain specialized lines, who have never taken a great interest in work of a public nature and who can be of the greatest inspiration and value to their associates if they become interested in the engineering society and secure the prominence in its discussions to which their experience entitles them. The spirit of coöperation developed by the investigation will be to the advantage of engineers throughout the state. Incidentally, the Providence Engineering Society is in a stronger position than ever before and its patriotic activities have been publicly acknowledged by both the Mayor of Providence and the Governor of the State.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Picture Language Is Required for Concrete Patent Suit

Sir—In *Engineering News* of Oct. 5, 1916, the writer gave an account of a patent decision against Frederick Melber, who had sued the School Board and the contractor and the architect of the Schenley High School for infringement of his patent on reinforced-concrete design. The case was decided against the patentee. This case was carried to the United States Circuit Court of Appeals for the Third Circuit and argued before that court in its March term. The decree of the lower court was affirmed in a decision handed down recently. The case was heard before Circuit Judges Buffington, Wooley and McPherson, and the opinion was written by the last named.

This case is interesting, not because there was ever ground, from an engineer's standpoint, for belief that the patents were either valid or infringed, but because there was confidence enough somewhere not only to finance a suit, but also to finance an appeal. The case is also interesting because of the nature of some of the arguments set forth by the complainant in his brief.

Part of Melber's patent was on a retaining wall consisting of vertical and horizontal slabs connected with ribs or counterforts. This shape of reinforced-concrete retaining wall had been patented many years before, and models had been tested and the tests made public as early as 1894. The remaining claims of his patent called for ordinary tension and compression reinforcement and included therewith a lot of disjointed shear rods. In a redesign of the Schenley High School the writer had eliminated many tons of loose shear rods; not a shear rod was used in the entire building. Main reinforcing rods were bent up toward the support to act in tension and by so doing relieve the concrete of what would otherwise be shear.

Some of the principal arguments in the case center about what is called Defendant's Exhibit *Y*. Owing to the bearing that the question has on reinforced-concrete design, the writer believes that both Melber's argument and the writer's device to combat the same will be of interest to the profession.

The accompanying sketch (Exhibit *Y*) is one made by the writer to illustrate before the court why bars *A* are in tension and not in shear (as claimed by Melber) and are therefore tension bars and not designed for shear, though they relieve the concrete beam of what would be shear in the concrete if the rods were absent. Engineers will understand how two beams *B* and *C*, if joined together by bars *A*, will, when loaded, give tension in the bars *A*. They will also see that these bars will be in tension, though they take up what would be horizontal *shear* between beams *B* and *C*; also, they carry the shear of the beam to the support. Laymen can also see this.

The writer believed that engineers and laymen would be able to see that the corresponding bars of the whole beam of Fig. 1 would also be in tension—he believed this until he read Mr. Melber's argument.

To quote from that argument: "Godfrey assumes that when the bending force is applied in both figures in the sketch, the eye-bars *A* are in diagonal tension. This is a complete error. In the case of Fig. 1, where there is no longitudinal separation between the upper and lower portions of the girder or beam, the upper portion or zone of the girder is shortened by the deflection, thus bringing the upper pivot bolts of the eye-bars closer together, while the lower portion or zone is elongated, thus spreading apart the lower pivot bolts of the eye-bars. Thus the two ends of each of the eye-bars *A* are forced toward each other, the eye-bars tending toward a vertical position, thus shortening said eye-bars. Thus, there is no *tension*, which would be merely an elongating strain or pull, but there is simply *compression* exerted on said eye-bars, tending to shorten them.

"Looking at Fig. 2, if it be theoretically assumed that the elements *B* and *C* fit together perfectly and uniformly, with mathematical or ideal contact surfaces—as is never attained in practice in timber—then somewhat

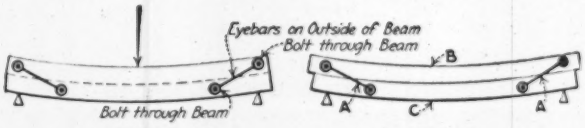


FIG. 1 FIG. 2

COURT EXHIBIT TO PROVE TENSION IN INCLINED RODS IN CONCRETE BEAM

the same result as above explained would occur in bending: Only to a lesser degree, owing to the free movement between the elements. However, there would be no *tension* at all. . . ."

To refute the arguments the writer prepared a model to be used before the Court of Appeals. A stick of wood about 1½ x 1 in. and 5 ft. long was used. On one side two mandolin strings were stretched in positions corresponding to eye-bars *A*. On the other side a continuous wire was stretched from end to end of beam, passing over screw-eyes at the third points of beam, to represent a bent-up-and-anchored tension rod.

The demonstration consisted in first taking the tone of the wire, with the beam laid across two books as supports and not loaded, then forcing down the middle

of the beam and taking the tone again. The tone rose very appreciably in all wires, proving conclusively that tension on rods in these positions will result from the loading of a beam. It is inconceivable that any tension could have been observed if the wires had been vertically placed to correspond with stirrups.

No further appeal can be made in this case, so that another menace is removed; and builders, who never heard of an obscure patentee and who would have purposely avoided the things laid down in his patent as essential, if they had seen the patent, will have just that much more freedom from annoyance and expense.

Pittsburgh, Penn. EDWARD GODFREY.

As Another Member Sees the American Water-Works Association

Sir—In view of the developments at the recent convention of the American Water-Works Association at Richmond, the beneficiaries of what has been termed "rotten politics" will probably not care to retain office secured under such conditions.

Broad-minded men with high ideals do not approve of underhanded work and would refuse to accept office where it was used in their behalf. Sometimes, a man is led into a scheme without realizing just what it means. That may have been the case in the recent election; if so, resignations will be promptly tendered.

Assuming that resignations will be tendered, President Leisen (whose election was legitimate, as was also that of Mr. Little), could call for a special election. The newly elected Executive Committee could then make appointments.

For the good of the society, this matter should be followed up with a thorough investigation.

Publicity is a good thing, and *Engineering News-Record* is to be commended for its course. Men who have not done anything to be ashamed of do not object to having the light turned on.

DOW R. GWINN,
President, The Terre Haute Water-Works Co
Terre Haute, Ind.

Women Draftsmen

Sir—I have read with interest the articles appearing for the past few weeks on the subject of replacing male draftsmen with women, and have remained silent even though I was tempted by Mr. Webb's contribution to burst into song. The spasm passed; but upon reading the paragraphs on page 82 of your issue of July 12, it comes again with renewed vigor.

Agreeing perfectly with the expressed opinion of the anonymous gentleman from Kansas City in so far as his observation touches upon the actual subject of discussion, I must nevertheless take issue with him in the matter of the qualifications of Messrs. Webb and Newell, whom I do not know. It appears to me that Mr. Webb is thoroughly conversant with his subject. Adding his bit to the excellent remarks of Mr. Newell, he proceeded to show that it is the experience of actual practice that, even though draftsmen be required to be technical graduates before they are considered for employment (although it was not until Kansas City came to the front that attention was called to this fact), their rate of pay is commonly fixed at about three-fourths that of Chinese and Hindu labor, and their status in the organization is on an equally high plane.

From this it would appear to be an entirely logical and proper conclusion that their places may easily be filled by women having two or three weeks' training in the use of the right-line pen, by well-balanced, healthy children recently graduated from the seventh grade, or by laborers who have sustained injuries and are convalescent. Among the Hindus particularly are many accomplished gentlemen whose talents and training should amply qualify them for positions of responsibility at the boards of your esteemed correspondents.

It would undoubtedly be a distinct economic waste to employ women in positions which any human automaton would seem to be able to fill with entire success and satisfaction to his employers, and with this in mind I confidently call these further suggestions to the attention of Mr. Newell and Mr. Webb.

Seattle, Wash. W. L. HILL, JR.

American Engineers Must Wake Up to Foreign Opportunities

Sir—Within the last few months two very interesting articles appeared in *Engineering Record* dealing with the engineer's relation to the expansion of American influence in foreign countries. These articles, written by Fred Lavis (Jan. 6, 1917, page 5) and Charles A. Stone (Nov. 25, 1916, page 659), should be read carefully by every American engineer who has the desire to go beyond the frontiers of the United States.

Having been connected with various enterprises in South America since 1902 and having witnessed the development going on in that continent, I have always been at a loss to understand the apathy exhibited in my own country toward the opportunities which exist in South America for the profitable employment of capital, provided the work is carried out under capable administration.

There are, of course, some radical differences between organizing and handling work abroad and within our own borders, but a man cannot learn to swim unless he goes into the water and tries. The English writer, Dr. Johnson, once said: "Nothing will ever be attempted if all possible objections must first be overcome."

UNITED STATES NOT THE ONLY FIELD FOR DEVELOPMENT

One of the favorite arguments, or rather excuses, put forward in the United States concerning the lack of interest shown in foreign development is that the American people have been so busy developing their own country that they have had no time or desire to take things outside their own borders seriously; and anyway, the United States is independent of the world. Mr. Stone points out the fallacy of this latter belief in the opening paragraph of the article referred to. Now, admitting that the expansion of our influence in undeveloped countries is desirable and that enterprises requiring the work and administration of engineers are as safe and profitable abroad as are similar enterprises of a domestic nature, the problem seems to be to get those who possess the necessary capital to realize that its employment in the development of new countries,

rich in natural resources and capable of sustaining a large population, is worth taking seriously. What force, or means, does the engineer possess to turn American capital in the foreign field?

Hundreds, yes, thousands, of pages of matter teeming with vital information relating to American development in the international field have been published in the last two years in high-class magazines of nation-wide circulation, but such matter seems to be regarded by the public more as "light reading" than as an exposition of facts the thorough digestion of which is of great importance to our national life and well being. On the other hand, in the great commercial countries of Europe the business man and the educated man read with understanding and due consideration that which concerns their country's influence and prestige in other lands, and in this respect they are much more wide awake than the American.

Technical Press Must Help

Narrowing down to the technical part, it is almost impossible to pick up a French, English or German technical periodical without finding one or more articles devoted to works being carried out in other countries. What we ourselves are doing is carefully watched and studied, and I do not think that I am making a misstatement when I say that, right now, the aims and purposes of the only two concerns in the United States really prepared to undertake engineering work abroad are better known and more widely commented on abroad than in the United States.

When we refer to our own technical periodicals we find really very little about what is going on in other lands, and unless the engineer is far-seeing enough to subscribe for several foreign papers he becomes saturated only with our own ideas and methods, which, while they may be ideal at home, require considerable modification and adjustment when an engineer is called on to carry out work abroad.

Mr. Stone remarks that some of our American technical schools are paying more attention to training men for work abroad. The importance of looking into what is being done in foreign countries cannot be too strongly impressed on students, and I have at times been astonished at the lack of such knowledge on the part of graduates of some of our universities.

I am glad to note Mr. Stone's recognition of Rensselaer in this regard, for that institution has been fortunate in possessing a faculty embodying men who have always taken a keen interest in engineering as an international profession and have demanded of undergraduates the same high standards and original thought that are required in French and German technical schools.

French Most Useful Language

It is not my intention to go into the qualifications needed to make an engineer successful abroad. A discussion of this subject would require a volume, and after all, success depends on the man and to some extent on the circumstances by which he is surrounded. But an important matter is the language equipment a man possesses. Just now the great idea seems to be for men to take up Spanish, but this may often be a mistake. From a truly international standpoint I would select French, as this language is fairly universal, outside of the United States, among people with whom engineers will have to deal in treating of important affairs. Of course, in handling working forces an engineer will have to know the language of the particular country in which he is located. For example, except in Brazil, which is the largest part of South America, Spanish is spoken; but in Brazil the language is Portuguese. This latter tongue is in many respects quite unlike Spanish. But one who is a master of French has gone a long way toward acquiring either Spanish or Portuguese. French is also invaluable in Russia, the Orient and Continental Europe.

Early Start Must Be Made

In conclusion I can only say that if Americans, laymen or engineers, are going to accomplish anything abroad the sooner they begin in earnest the better. The firm intrenchment of American prestige and influence is going to be no easy matter, and first attempts will not always meet with instant success. There is a long, hard road ahead, and we are under an enormous handicap, largely due to the lack of active interest on the part of our own people. Though the countries in whose development we should strive to take part will welcome us, we must do our share by taking up this work with an open mind, studying each proposition from all angles, taking advantage of what is suitable and rejecting what is unsuitable in our own methods, if we are to accomplish, and to bring to a successful and practical conclusion, the work with which we may be intrusted.

Charles J. Seibert,
Resident Engineer, Trussed Concrete Steel Co.
Rio de Janeiro, Brazil.

Road Work Can and Should Be Continued

Sir—In regard to the present road situation, I think that highway-work can and should be continued, possibly not as extensively as during better conditions, but enough so that contractors can keep their organizations intact and their plant investment working. The state has many short connecting roads to let, on which the cost will run high anyway, whether they are let this year or after conditions change. They are small jobs, but about all a contractor dares undertake at this time.

Labor is, of course, scarce, but at present we have enough. We must compete with the electrochemical plants at Niagara Falls and pay 30c. per hour for 10 hours. Teams are 55c. per hour. They are farm teams which otherwise would be idle at this time.

In regard to changing the form of contract, I feel that something should be done at this time to help out the contractor and relieve him from the gamblers' chances which he must now take. I would like to see a cost-plus-a-fixed-sum contract used. Competitive bids could be received on the fixed sum, which would include rental of necessary plant. Cost should of course include labor, materials, supplies, bonds and insurance. Payments of cost should be made monthly, and the fixed sum held until work is entirely completed. The state is already familiar with the abilities of its contractors and therefore would be able to place these contracts with dependable firms.

Walter C. Rich,
Treasurer, Rich Construction Co., Inc.
Youngstown, N. Y.

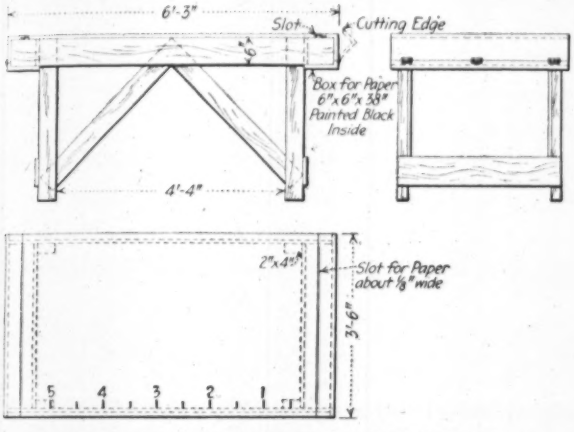
THE ENGINEER IN FIELD AND OFFICE

A DEPARTMENT DEVOTED TO DETAILS OF THE DAY'S WORK

Special Blueprint Table Combines Several Functions

By C. B. Coe
Mead Pulp and Paper Co., Chillicothe, Ohio

THE table shown in the sketch combines the functions of the storage can, the scissors and the yardstick. The roll of paper is stored in the box at the end



BLUEPRINT TABLE SAVES TIME AND PAPER

and pulled out through the solt, measured with the foot marks and torn off on the cutting edge. Less than ½ in. of paper is spoiled, and this only when the strip is left exposed for a considerable length of time. At least this much is ordinarily wasted by excess cutting. The left-hand box is used for odd sheets of paper, but may be slotted and used for a different grade of paper.

Oiled Macadam Roads Smoothed by Plank Drag

OLD macadam roads that have been surface-treated with bituminous materials are smoothed and resurfaced by the Connecticut State Highway Department largely through the use of the plank drag, hitherto chiefly advocated only for gravel- and earth-road maintenance.

The worn-out surface is first scarified or, more accurately, "combed" with a spike-tooth scarifer or harrow drawn behind a motor truck, as shown in the accompanying view. The best method has been to hire the truck and driver, which can be done for $20 per day.

The harrow loosens the stone to a depth of about 2 in. on the high places, after which the road is dragged with a regulation plank road-drag. This smooths the surface, filling the smaller depressions and scraping the loose stone to the edges of the road. This loose material is then used to even the surface and bring it back to grade. After being rolled and surface treated, the pavement, according to C. J. Bennett, state highway commissioner, is nearly as good as new.

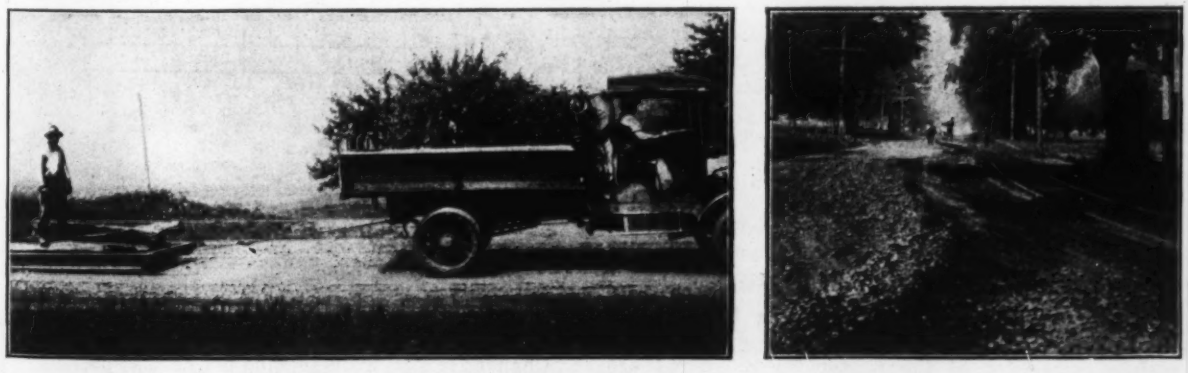
Must Post Bridge Capacity in New Jersey

County authorities in New Jersey have been notified by the state commissioner of motor vehicles, W. L. Dill, to post the carrying capacity of every bridge in a conspicuous manner, as warning to truck drivers. Vehicles that attempt to cross bridges whose posted capacity is too low for the weight of the vehicle will do so at their own risk. The new requirement is due to increase in market hauling and other freight business by motor truck.

A Manning Formula for Flow

By L. Chivvis and C. N. Monteith
Office of Sewer Design, St. Louis

THE Chezy-Kutter expression for mean velocity of a uniformly flowing stream involves the three variables n, R and S in a rather awkward relationship. This fact limits its practical use to office work where diagrams are available. The need of a less complicated expression has led to the introduction of many formulas having for the exponents of R and S odd decimals which more nearly conform to true conditions of flow than do



MOTOR TRUCK PULLS ROAD DRAG OVER SURFACE

the exponents in the Chezy formula. The C term in these formulas is, for this reason, simpler than Kutter's C, since the latter must necessarily contain corrective terms to balance the deficiencies of the basic equation, $V = C\sqrt{rs}$.

The Manning formula, $V = \frac{1.486}{n} R^{\frac{2}{3}}S^{\frac{1}{2}}$, is of this type. It is apparently not founded on actual experiment, although the lack of published data on the formula leaves the question of its origin open to some doubt.

The probable method of derivation, however, is as follows: By solving the Kutter equation for a range of sizes commonly met with in sewer design, assuming

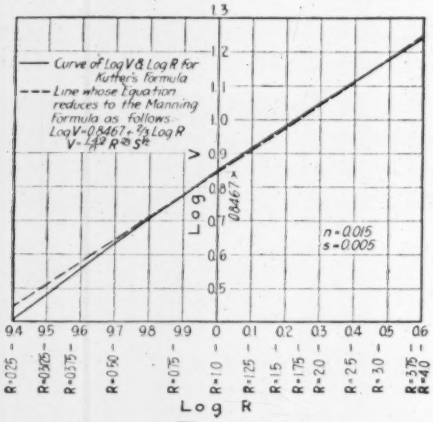

Curve of Log V & Log R for Kutter's formula
Line whose Equation reduces to the Manning formula as follows
Log V = 0.8467 + 2/3 Log R
V = 1.49 R^2/3 S^1/2
n = 0.015
s = 0.005
Log V
Log R

FIG. 1. DERIVATION OF MANNING FORMULA

typical values of $n = 0.015$ and $S = 0.005$ throughout, a series of velocities is obtained which is dependent on R alone. If the logarithms of these velocities are plotted with those of the corresponding radii, a slightly curved line is obtained, the general inclination of which, between the values of $R = \frac{2}{3}$ and 4, can be closely approximated by the equation

$$log\ V = 0.8467 + \tfrac{2}{3}\ log\ R \quad \text{(See Fig. 1)}$$

This can be reduced to a flow formula of the Manning type, the Y intercept 0.8467 being equal to log $\left(\frac{c}{n}S^{\frac{1}{2}}\right)$. In this case $c = 1.49$ and the formula is $V = \frac{1.49}{n}R^{\frac{2}{3}}S^{\frac{1}{2}}$.

The above linear equation, with its limiting values of R, was chosen with a view of keeping the variation between it and the Kutter curve less than 1%, this being well within the probable error of the latter.

By raising the line, keeping the inclination at $R^{\frac{1}{2}}$, the coincidence with the Kutter curve is closer, but the range of this coincidence is smaller. Thus, the expression $V = \frac{1.5}{n}R^{\frac{2}{3}}S^{\frac{1}{2}}$ gives a maximum error of only 0.6% between $R = 1$ and 3, but is at wide variance above and below these values.

MANNING FORMULA NOT FOR ALL-AROUND USE

Although the agreement is close for these limited ranges, it cannot be said that the Manning formula is a serious competitor of the Kutter for all-around use. This is particularly true for office work. Most of the computations for the capacity of circular or egg-shaped sewers can be solved directly in terms of discharge from graphs drawn up for standard values of n. For shapes other than circular, this office is now using a large-scale graph similar to that given in Hering & Trautwine's translation of Kutter's work. Entering this graph with $\sqrt{R}$, n and S, the Chezy C is obtained.

The field of the Manning formula would seem to lie in such work as irrigation reconnaissance or the laying out of temporary water and sewerage systems for military camps. It should not be used for permanent installations without an understanding of its variations, some of which are:

Every change in n, the coefficient of roughness, produces variations in the general slope of the log V log R curve platted from Kutter's formula, keeping S constant. This necessitates a different exponent of R, as well as a different constant in the exponential formula if the maximum range of coincidence for this degree of roughness is to be realized. Fig. 2 illustrates these

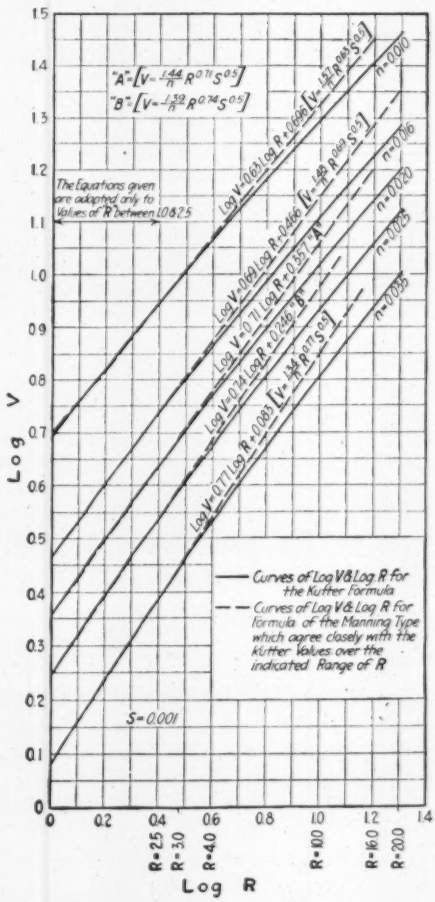

"A" [V = 1.44/n R^0.71 S^0.5]
"B" [V = 1.32/n R^0.74 S^0.5]
The Equations given are adopted only to Values of R between 1.0 & 2.5
Log V = 0.841 Log R + 0.0686 [V = 1.47/n R^0.84 S^0.5]
Log V = 0.841 Log R + 0.0466 [V = 1.49/n R^0.84 S^0.5]
Log V = 0.71 Log R + 0.1761 [V = 1.49/n R^0.71 S^0.5] "A"
Log V = 0.74 Log R + 0.1249 [V = 1.32/n R^0.74 S^0.5] "B"
Log V = 0.771 Log R + 0.0835 [V = 1.34/n R^0.77 S^0.5]
n = 0.010
n = 0.013
n = 0.020
n = 0.025
n = 0.035
S = 0.001
Curves of Log V & Log R for the Kutter Formula
Curves of Log V & Log R for formula of the Manning Type which agree closely with the Kutter Values over the indicated Range of R
Log V
Log R

FIG. 2. GRAPHICAL COMPARISON OF KUTTER AND MANNING FLOW FORMULAS

variations. It is seen, however, that for $n = 0.016$, the equation agreeing best with Kutter over a range of R from 1 to 2½ (for circular sections—4 to 10 ft. in diameter) is practically the Manning formula.

Changes in size, while they do not have as pronounced an effect as changes in roughness, produce variations in the R exponent which must be considered in extreme

cases. This is illustrated by a formula which was used in this office for the design of some rather large concrete-lined channels having an assumed roughness coefficient of 0.016 and varying in hydraulic mean depth from 4 to 20. For slopes of about 0.001 the expression which best fitted the Kutter formula for this range of R was

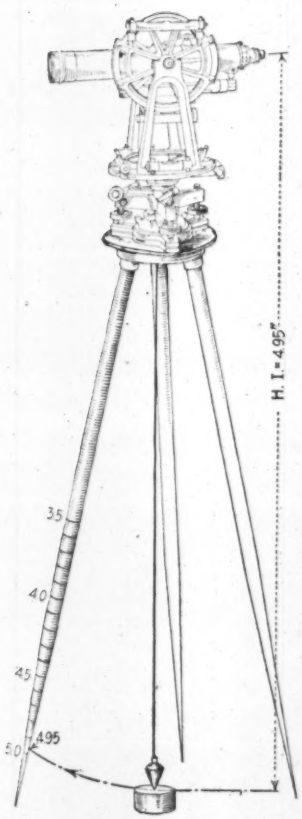
$$V = \frac{1.61}{n} R^{0.6} S^{0.5}$$

the maximum variation in velocity being 1.6%. Changes in slope have very little effect within practical limits.

It might be argued that, since the Kutter formula itself is far from perfect, its use as a standard of reference for any other formula is open to criticism. However, the limitations of this formula have been fairly well determined, and with these in mind it may serve as a basis for an approximate determination of the accuracy of the Manning formula. This requires much less time than the laborious and somewhat unsatisfactory task of proving the derivation of a formula such as Manning's by working up a long series of actual experiments.

Scale on Transit Leg Fixes H. I.

By William Halvernberg
New York City



HEIGHT OF INSTRUMENT HEAD FROM TRIPOD LEG

An easy method of establishing the height of instrument of a transit where this is needed, as in stadia surveys, is to fix a scale on one of the tripod legs by which the length of plumb-bob string and hence the H. I. may be gaged. The procedure of placing and using the scale is as follows:

Set up the transit over the hub and measure the H. I. carefully and accurately. Have the point of the plumb-bob just touch the tack or wherever the H. I. is measured from. Swing the point of the bob to one of the legs of the transit and mark this point on the transit leg. By similar markings scratch a scale on the transit leg, using feet and tenths. Then at any time, with the point of the bob touching the tack at any set-up, the H. I. may be read directly on the leg of the transit by swinging the bob in an arc and reading the point of the bob. This will give results to the nearest hundredth, which is generally close enough

Bureau of Mines Prepares Gasoline Specification for Government Use

The method adopted by the Bureau of Mines in preparing specifications for Federal purchases of gasoline in the District of Columbia was, briefly, as follows:

Samples of the various types of motor gasoline sold in the District were analyzed. A specification was then written which represented the average product already on the market, previous experiences having indicated this to be satisfactory. The procedure adopted made it possible for the Federal Departments to obtain motor fuel suitable for the motors in use, and equal in quality to that dispensed to private users. While this method of determining specifications is not absolutely scientific, it is highly practical and resulted in the following specifications:

Color

Requirement—Water white.

Method of Determination—Inspection of column in 4-oz. sample bottles

Acidity

Requirement—Total absence.

Method of Determination—Ten cubic centimeters of the gasoline is to be shaken thoroughly with 5 cc. of distilled water. The aqueous extract must not color blue litmus paper pink.

Volatility

Requirement—The gasoline shall, when distilled by the method described in Technical Paper No. 166 of the Bureau of Mines, meet the following requirements:

A. The temperature read on the thermometer when 20% has distilled shall not be below 70° C. (158° F.), nor above whatever limit is fixed after due consideration of conditions of use.

B. The temperature read when 90% has distilled shall not be above another limit similarly chosen.

C. The temperature read when 50% has distilled shall not be higher than a mark halfway between the 20% and the 90% limit.

D. The dry point shall not exceed the actual 90% reading by more than 55° C. (99° F.).

Tolerance—If either the 20% or the 90% temperature mark is above the required limit by an amount not exceeding 10° C. (18° F.), the gasoline may be considered acceptable if the sum of the two temperatures read for the 20% and the 90% marks does not exceed the sum of the adopted limit.

French Laboratory Glass Is Excellent

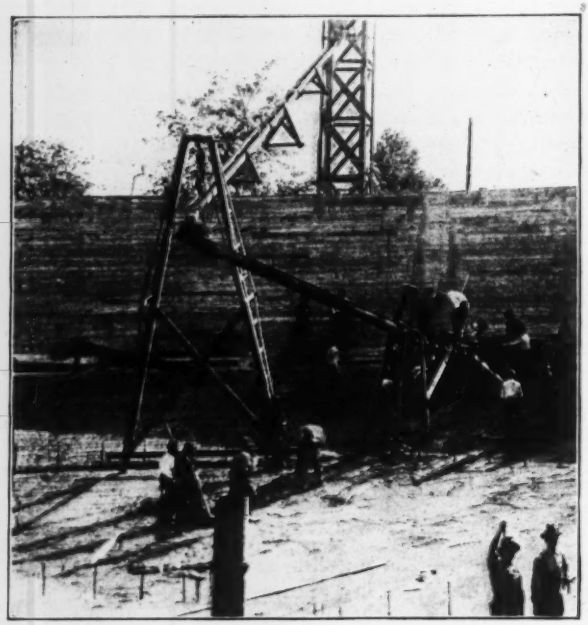
Laboratory glassware now made in France has been found equal to the best Thuringen and Jena ware in resisting the action of water (below, at and above 100° C.), hydrochloric acid, ammonia and $N/10$ solutions of ammonium chloride and sodium carbonate, according to a writer in *Comptes Rendu*, noted in the *Journal* of the Society of Chemical Industry, Nov. 30, 1916. Superior ability to withstand sudden cooling was observed only with Jena and with one make of Bohemian glass.

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Concreting Plant for Circular Reservoir

ONE of the concreting outfits used in building the 3,000,000-gal. 160-ft. reservoir for the new training camp at Fort Benjamin Harrison, near Indianapolis, Ind., is shown in the accompanying view. The floor concrete is being deposited. The elevator bucket in the outside tower discharges through a hopper into the long steel chute, which is made rigid by truss rods and wooden struts. The lower end of the chute is carried by tackle in an A-frame whose posts are stiffened laterally by plank bracing. This frame rests on the floor of the reservoir.



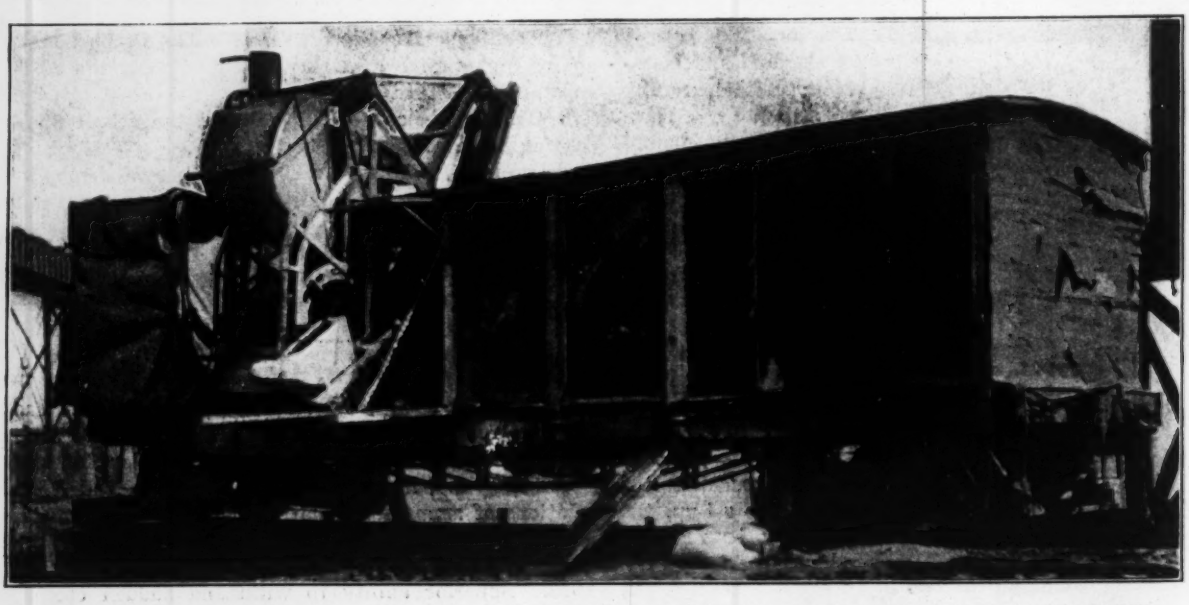
CONCRETING RIG FOR A CIRCULAR RESERVOIR

This and a smaller A-frame carry another length of steel chute, beyond which are two wooden chutes. One is supported on horses, and the other has a horse at one end only, the lower end delivering the concrete in place. One of these wooden chutes is shown at the left. This makes a very flexible arrangement for distributing the concrete over the area of the floor. The reservoir was designed by C. H. Hurd, of Indianapolis, Ind., and was built by the Gaylord Engineering and Construction Co., of Scranton, Penn. The work was under the direction of Brigadier-General Glenn, U. S. A. The construction occupied only about 30 working days.

Hopper on Baggage Truck Saves Taking Sacks Out of Cement Shed

BY W. F. COLLAR
General Superintendent, Municipal Bridge, St. Louis

IN THE track-mixing plant seen in the photograph the sacks were never taken outside the cement shed. The wood hopper, shown in the picture, was mounted on a common truck and was used to dump the cement into the loading hopper of the mixer. The cement sacks were emptied into the small truck hopper inside of the car and put into a sack-baling and counting machine in one operation. This procedure not only saved time, but made a large saving through eliminating any loss of cement sacks through theft or ordinary carelessness.



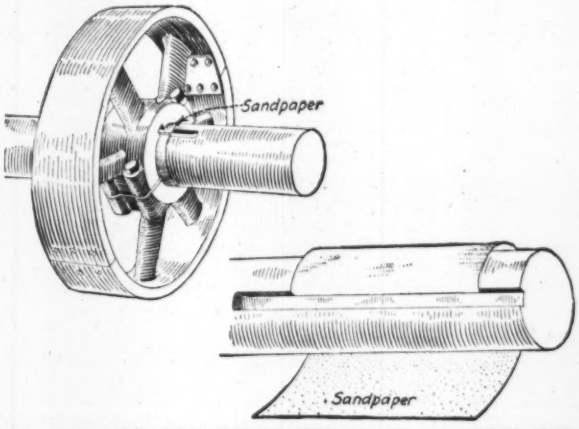
SACKS NEVER LEAVE HOUSE, CEMENT BEING CARRIED TO MIXER IN SMALL HOPPER ON BAGGAGE TRUCK

The mixing plant, which was used in pouring the footings for the East St. Louis approach, was mounted on a flat-car on one end of which the cement house was built. At the time the photograph was taken the outfit had been in use two years.

Sandpaper Replaces Broken Key on a Split Pulley

By H. S. Carpenter
Billmyer, Penn.

In August, 1916, the key on a drive pulley of a No. 9 McCully crusher sheared off and an immediate repair was necessary. As a temporary expedient, the pulley



A LAYER OF SANDPAPER TAKES PLACE OF STEEL KEY

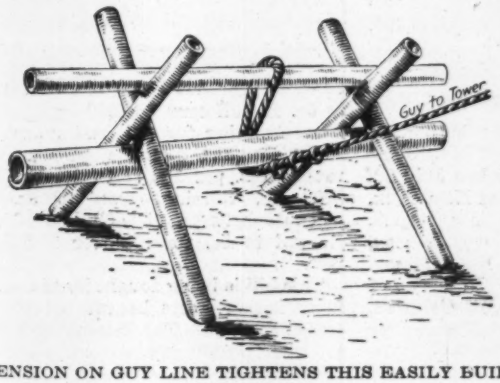
was unbolted, spread, and a layer of sandpaper was placed between the pulley and the shaft. The holding-bolts of the pulley were then drawn up tight and the crusher put into operation.

As a special precaution, the bolts were pulled up as tight as was possible; and though trouble was expected, none developed—the pulley driving the crusher without slipping and giving perfect satisfaction to date.

Make Self-Tightening Anchor of Wrought-Iron Pipe

By J. A. C.
Sistersville, W. Va.

On the Sistersville filtration-plant construction, William Francis, of Dayton & Francis, contractors, New Martinsville, W. Va., have built and used successfully an anchorage for a concrete-tower guy line of the construction shown in the accompanying drawing. Wrought-iron pipe of 2- and 3-in. diameter was used—two sets of two each being driven into the ground in the form of an X and carrying transverse pipe above and below the point of crossing. The guy rope was then wrapped around these horizontal pipes.

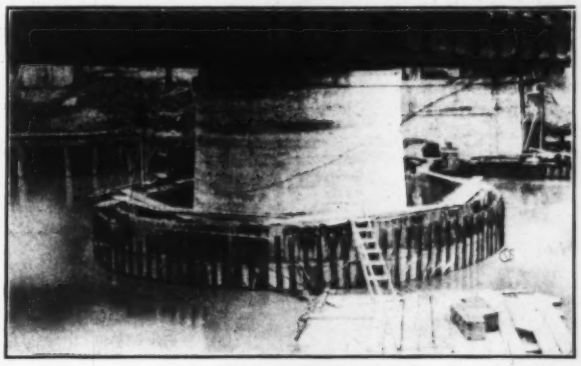


TENSION ON GUY LINE TIGHTENS THIS EASILY BUILT ANCHORAGE

Any pull or jerk on the guy line has a tendency to pull together the two crosspipes and tighten the crossed pipe in the ground. The pipes, being of small diameter, are easily driven into the ground—needing no digging and therefore getting their reaction against solid earth. Furthermore, instead of being clumped and mutually weakening each other through any movement, they are separate and, having each its own bit of earth to push against, are enabled to get a solid reaction.

Drive Old Rails for Cofferdam Around Piers in Hard Bottom

In the construction of a bridge pier at Mt. Clemens, Mich., for the Detroit United Ry. lines, old street-railway rails were driven instead of wood sheet piles because of the hard bottom. The inner row was driven



TWO ROWS OF OLD RAILS MAKE BRIDGE-PIER COFFERDAM

with the heads adjacent to the flange of the next rail around the circle. At intervals the heads were clamped to the flanges by bolts, fillers and by plates. For the outer row the rails were driven with the heads pointing in toward the center of the circle and just far enough apart to take a 2 x 12-in. plank between adjacent rails—thus making a nearly watertight job.

RAILS WERE DRIVEN FACE-TO-FLANGE AND SIDE-BY-SIDE

NEWS OF THE WEEK

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

National Guard Camp Now Well Under Way

First Group Will Be Ready for Occupancy by August 15—Others by September 1

Reports of the progress of construction work at the Southern camps to which the National Guard divisions will be sent have been assembled by the Quartermaster's Department, and the following facts are given out:

The adequate provision of a water-supply is the most vital point to be considered in putting a camp in condition to receive troops.

The work at each site includes providing railroad sidings, roads, buildings for mess houses, regimental, brigade and divisional headquarters, and storehouses. About 4,500,000 ft. of lumber is required at each camp. Installation for electric power and lighting must be provided in each camp.

The constructing quartermaster for each camp, after conferring with the cantonment division officer, was sent to the work as quickly as possible. In every case they arrived within a few days after orders had been given to proceed.

Camps Divided Into Groups

The plans, as originally made, divided the camps into three groups, to be completed on Aug. 1, Aug. 15 and Sept. 1, to accommodate National Guard divisions brought into Federal service on July 15, July 25 and Aug. 5 respectively.

As conferences over the relative merits of available sites were not concluded until very recently, the beginning of work was delayed until long past the time originally planned. It was recognized that completion of any camps by Aug. 1 was out of the question. It is now possible to state, however, that the first group of camps will be ready for occupany less than two weeks after the date originally set. Camps in the other two groups will be ready for occupancy on Aug. 15 and Sept. 1 respectively, as scheduled.

Groups as Originally Planned

The groups, as originally planned, are as follows:

For Completion Aug. 1—Augusta, Ga.; Deming, N. M.; Montgomery, Ala.; Spartanburg, S. C.; Waco, Texas.

For Completion Aug. 15—Anniston, Ala.; Charlotte, N. C.; Greenville, S. C.; Houston, Tex.; Palo Alto, California.

For Completion Sept. 1—Alexandria, La.; Hattiesburg, Miss.; Fort Worth, Tex.; Fort Sill, Okla.; Linda Vista, Calif.; Macon, Georgia.

Co-operative Roadwork in Oregon

Approval has been given by the Secretary of Agriculture for coöperative roadwork in Oregon, involving $1,114,-194, which is distributed in 15 projects. This amount is matched by the state, assisted in some instances by counties. The projects covered by this announcement are: McKenzie Pass Road, 44 miles; Mount Hood-Loop Road, new construction, 25 miles; Eugene-Florence road, 18 miles; Pendleton-La Grande Road, 15 miles; Medford-Klamath Falls Road, 25 miles; Ochoco Creek Road, 13 miles; Canyonville-Galesville Road, 8 miles; Reedsport-Coos Bay Road, 6 miles; Little Nestucca, 5½ miles; John Day project, 20 miles; Flora-Enterprise Road, 12 miles; La Pine-Lakeview Road, a part of the main north and south highway of eastern Oregon, 5 miles; Pilot Rock-Prairie City Road, 16 miles; Crescent-Klamath Falls Road, a part of the main north and south highway, east of the Cascade Range, 22 miles; Zigzag Road, part of the main highway to Mount Hood and eastern Oregon, 11 miles; location surveys and the letting of contracts and other preliminaries necessary will be made at once.

Idaho Votes Million for Roads

Governor Alexander of Idaho has signed the road bill of that state, and almost a million dollars is to be expended in the next two years on the road from Moscow through Lewiston, to Weiser and southern Idaho, a connection with the transcontinental highway to Portland and Seattle. Under the Post Roads bill the United States Government will appropriate $150,000 for the road, the state will provide $375,000, and the balance will be furnished by the counties. For the highway from Montana to Lewiston, which will connect with the automobile highway to Portland and Puget Sound, Idaho has appropriated $30,000, the Forestry Department $30,000, and the counties $30,000.

Governors Appoint Harbor Commissioners

A step toward the coördination of the facilities of the port of New York and its development was taken July 20, when Governor Whitman, of New York, appointed Arthur Curtis James, Eugene H. Outerbridge and William H. Wilcox, and Governor Edge, of New Jersey, appointed De Witt Van Buskirk, of Bayonne; Frank R. Ford, of Caldwell, and J. Spencer Smith, of Tenafly, as members of the New York Harbor Commission.

St. Louis Water Rates Again Under Revision

Legislature Takes Control of Rates Away from Missouri Public Service Commission

Editorial Correspondence

The revision of water rates for the City of St. Louis is again before its Board of Aldermen. This rate revision has had a checkered career, running back over a number of years.

Prior to 1914 the city had a schedule of flat rates and also meter rates for domestic consumption and a rate of 6c. per 100 cu.ft. for manufacturing purposes. In 1914 certain ordinances were passed at the request of the assessor of water rates and inadvertently the section allowing the 6c. rate to manufacturers was repealed. About this time the assessment of water rates was put under the control of the water commissioner, who proceeded to assess the manufacturers at the regular rates. This produced an immediate protest. A new ordinance was passed in 1916 establishing for manufacturing purposes a rate of 4½c. per 100 cu.ft. This was followed by protests from the Civic League and certain improvement associations, alleging undue discrimination against the domestic consumer. These associations carried the matter before the Missouri Public Service Commission, which handed down a ruling, effective Dec. 1, 1916, requiring the City of St. Louis to establish uniform rates plus service charge for all purposes. The time allowed for the establishment of this rate was extended from time to time. Meanwhile the opponents of uniform rates secured passage of a bill in the state legislature which took away from the Missouri Public Service Commission any and all powers to regulate the rates and services of municipally owned water-works in cities of over 300,000 inhabitants.

There is now pending before the Board of Aldermen a bill revising the water rates, which puts the domestic consumers and the manufacturer on a sliding scale. In the case of a manufacturer, the rate begins at 12c. per 100 cu.ft. for the first 10,000 and runs down to 5c. for all over 150,000 cu.ft., these amounts being for the semi-annual period. For the domestic consumer the rate is 15c. per 100 cu.ft. for the first 3000 ft., running down to 9c. for amounts between 150,000 and 260,000 ft. and to 5c. for all over 18,000,000 feet.

This bill is being fought by the manufacturing interests because of the increase to them. The increase is a considerable percentage to small users and about 20% for the very large consumers.

Lower Court Rejects Luten Patent Claims

In Case Partly Defended by State of Nebraska—Familiar Bridge Patents Not Upheld

Judge Munger, sitting in the United States District Court for the district of Nebraska, has just handed down a decision dismissing a bill of complaint brought by Daniel B. Luten against the Wilson Reinforced Concrete Co. et al. for infringement of certain claims in Luten's patents on concrete bridges. This is one of the cases in which the state stepped in to help defend, through the attorney general, infringement suits brought against contractors who had built structures for the state.

Principles Are Old

The main rulings were on three patents, Nos. 853,202, 853,203 and 818,386. The first of these is on a "concrete bridge having a concrete spandrel extended back of the abutments with upright rods or bars embedded near the ends of the spandrel." The judge decided that such a structure was anticipated by a number of patents and publications. Patent No. 853,203 relates mainly to the placing of transverse reinforcement in an arch rib. The judge ruled that the old Monier webbing reinforcement constituted a substantial anticipation. The last patent, No. 818,386, is on the familiar Luten arch-rib reinforcement, in which the rods are bent up from intrados to extrados at varying distances along the haunch. As to these claims the judge said that they "attempt to cover the positioning of members where stresses will occasion fractures. The principles that govern the location of the danger points from live loads were old when Luten entered this field. Writers and inventors had indicated the methods of correcting these dangers by the use of tension members substantially as Luten's patent attempts to apply the correction. In view of the state of the art, Luten cannot be said to have supplied more than ordinary mechanical or engineering skill in giving functions to tension members when applied to the problem of arches upon which is to be imposed a live load."

Missouri To Use Convict Labor on State Road Construction

According to an announcement made July 22, by the Missouri State Highway Commission, a conference with members of the State Prison Board resulted in a decision to use the convicts in the state penitentiary at Jefferson City in working the roads. Under the tentative plan the state prisoners will be equipped by the Highway Commission and the Prison Board, each sharing the expense. While the prisoners are working the road the expense will be borne by the Highway Commission.

The convicts also will be available to the counties for work on the roads. All of the money resulting from their work will go to the state. The men will be placed in camps in the district where the work is to be done—the camps—accommodating 50 to 200 men.

Task of U. S. Engineer Regiments in France

Will Make All Preparations for Our Armies from Wharves to Camouflage —Will Furnish Water Supply

The following statement relative to operations, projected and under way, to accommodate American armies on their foreign expeditions was authorized by the Office of the Chief of Engineers of the Army:

The value of railroad materials and rolling stock alone, now being purchased to provide in advance for the needs of the American Army, is about five times that of all purchases made annually in this country for the Panama Canal during the last four or five years.

American engineers must undertake large operations in the construction and repair of bridges in France. They must repair and maintain the roads and highways over which our supplies will be brought up to the battle line. Much of the latter work will be done within range of the enemy's guns. To accomplish this work the same kind of street and road equipment as is used in our leading American cities will have to be shipped to the front.

Will Equip French Terminals

Our engineers will equip the wharves and piers in France utilized by American forces, with the terminal facilities required by our armies. The lumber for this work will be cut from European forests by regiments of American foresters. This method will save burdening our ships with lumber from the United States. One regiment of foresters is being organized and several more will be raised. They will carry with them complete lumbermen's outfits, including sawmill equipment.

Experts will install electric plants which will furnish lights to the trenches, dugouts, storehouses, etc. The power houses will be "dug in" in such a way as to protect them from shell fire.

Will Furnish Water-Supply

It is the duty of the Corps of Engineers to furnish an adequate water-supply for the large bodies of men suddenly placed in localities where the entire water-supply is already needed for the small civilian population. Our experts are already in France studying this problem. Well-driving apparatus, pipe and all necessary supplies will be sent over. Settlements in which our troops will stay will be piped as is done under an American city system. Material for extensive standard-gage and narrow-gage railroads will be sent to Europe, to enable the engineers to carry out their task. The lines to be built will both transport our troops to the front and handle all transportation behind the firing line. The lines running up to the front will remove wounded and salvage gathered from the field. Lines of this type are broad-gage, feeding numerous narrow-gage spurs which radiate from the main line and accommodate supply trains often hauled by gasoline engines.

The Engineer Corps will carry its own rolling stock to the theater of war. This in itself will be a gigantic operation.

Special mining companies will be formed for the purpose of carrying on the intricate operations involved in modern trench warfare. For this work expert miners will be chosen.

The engineers will go into the study of battle map making on a large scale. They will study this work under expert British and French instructors, who have made a specialty of the fields of battle since the war began. The present war has brought into being a vast number of appliances hitherto unknown. Battlefield illumination with searchlights, trench lights, flares, star bombs and rifle grenades will be handled by our engineers. Appliances for this work will be of American manufacture.

Will Apply Camouflage

Camouflage, the modern war art of reducing the visibility of objects, must be applied for the protection of our troops, artillery, etc., in France, and our engineers are making this subject their special study. Well-known artists and experts in color effects will precede the engineers and study out the problem of obscuring our operations from the enemy. The actual work will be done by sign painters and soldiers trained in the craft.

The engineers will attend to the construction of all buildings for the housing of troops. They will build hospitals, refrigerating plants, machine shops and other structures incident to the care and supply of the army in France.

The purchasing and supply department of the Engineer Corps faces the task of buying the equipment that must be shipped to the front. The item of intrenching tools is in itself a considerable one, as the destruction in this one particular has been very large in the French and British armies. Wrecking cars and all the paraphernalia which goes with them must be supplied. Complete equipment for the making of concrete must also be provided.

The engineers must construct at harbors in the United States wharves, piers and storehouses of sufficient capacity to handle all materials and supplies to be shipped to France. Every effort is being made to put through the work on hand without clogging the machinery. It will be the endeavor of the engineers to prepare accommodations ahead of troops as fast as they are sent over to the front, but they will not try to provide for our entire army all at once.

Vancouver To Have New Shipyard

The Griswold-O'Donnell Co., of Portland, Ore., is the latest shipbuilding firm to be organized, and it will erect a plant on the waterfront at Vancouver to have four ways. Plans for machinery to accommodate eight ways have been completed, and the second unit will likely be put in shortly. Room is also leased for a sawmill to accompany the yard.

Garbage Reduction Recommended to Mayors of Large Cities

Because of the shortage of fats and fertilizers throughout the world, Secretary of Agriculture Houston has advised the mayors of the large cities of the country to adopt garbage reduction. He wrote: "Garbage contains on the average about 2% of grease and about 20% of tankage, the latter having valuable properties as a fertilizer material. Any method of disposal of garbage in large cities which does not recover both the grease and the tankage is uneconomic and particularly deplorable in the present circumstances. We wish therefore to urge upon your consideration the advisability of so treating the garbage from your city as to insure the recovery of its valuable constituents. That this may be made a source of profit to a municipality has been proved by numbers of cities in the United States where municipal rendering plants have been erected, and in a number of others private plants are now operating and paying dividends on the investments."

Illinois Engineer Regiment Now at Full War Strength

The First Regiment Illinois Engineers (National Guard), organized in Chicago as the "Citizens' Unit," has reached a total enlistment of 1095 (officers and men), and a reserve battalion is proposed. One company is now at Camp Grant, Rockford, Ill., the others are quartered on the Municipal Pier at Chicago. The regiment is expected to be mustered into the Federal Service very shortly. Col. Gordon Strong, who was active in the organization of this regiment, has been commissioned as colonel of the Third Artillery, and is succeeded in command by Col. Frank L. Beals, who has been instructor at the Northwestern Military Academy.

New Law Frees More Convicts for South Carolina Roadwork

The provisions of the new law recently passed by the South Carolina legislature, forbidding the hiring out of state convicts to any individual or corporation, will make available for roadwork a considerable number of convicts who have hitherto been denied the state authorities. According to W. S. Fallis, state highway engineer, the logical place to use these men is on roadwork, most probably on the Hickory Nut Gap section, for the opening of this stretch of road will make the convict camp already established in Rutherford County more easily accessible to Hendersonville, from which all its supplies and materials are obtained.

Starts Sanitary Engineering Bureau

The Nebraska State Board of Health now has a Bureau of Sanitary Engineering, with headquarters at Lincoln. H. P. Letton, sanitary engineer of the United States Public Health Service, until recently located at Chicago, has received a year's leave of absence for the purpose of serving as chief.

Army Training Camps Under Construction

NATIONAL ARMY

No. of Division	Location	Name of Camp	Constructing Quartermaster	Contractor
76	Ayer, Mass.	Devens	Capt. Edward Canfield, Jr.	Fred T. Ley & Co., Springfield, Mass.
77	Yaphank, L. I.	Upton	Maj. O'Kelly Myers	Thompson Starrett Co., New York City
78	Wrightstown, N. J.	Dix	Harry O. Williams	Irwin & Leighton, Philadelphia, Penn.
79	Annapolis Junction, Md.	Meade	Maj. Ralph F. Proctor	Smith, Hauser & MacIsaac, N. Y. City
80	Petersburg, Va.	Lee	Captain Edward	Rinehardt & Dennis, Charlottesville, Va.
81	Columbia, S. C.	Jackson	Maj. William Couper	Hardaway Constructing Co., Columbus, Ga.
82	Atlanta, Ga.	Gordon	Maj. James N. Pease	Arthur Tufts Co., Atlanta, Ga.
83	Chillicothe, Ohio	Sherman	Capt. Ward Dabney	A. Bentley Co., Toledo, Ohio
84	Louisville, Ky.	Taylor	Maj. F. E. Lamphere	Mason & Hanger, Richmond, Ky.
85	Battle Creek, Mich.	Custer	Maj. Earle B. Morden	Porter Bros., Detroit, Mich.
86	Rockford, Ill.	Grant	Maj. D. H. Sawyer	Bates & Rogers Construction Co., Chicago, Ill.
87	Little Rock, Ark.	Pike	Maj. John R. Fordyce	James Stewart & Co., New York City
88	Des Moines, Iowa	Dodge	Maj. M. A. Butler	Charles Weitz & Sons, Des Moines, Ia.
89	Fort Riley, Kan.	Funston	Capt. J. F. Herman	George A. Fuller Co., New York City
90	Fort Sam Houston, San Antonio, Tex.	Travis	Capt. George E. Thorne	Stone & Webster Co., Boston, Mass.
91	American Lake, Wash.	Lewis	Capt. D. L. Stone	Hurley Mason Co., Tacoma, Wash.

NATIONAL GUARD

26	Charlotte, N. C.	Green	Maj. C. H. Greene	Consolidated Eng. Co., Baltimore, Md.
27	Spartansburg, S. C.	Wadsworth	Lieut. Col. J. D. Kilpatrick	Fisk-Carter Construction Co., Greenville, S. C.
28	Augusta, Ga.	Hancock	Maj. Gratz B. Strickler	T. O. Brown Co., Augusta, Ga.
29	Anniston, Ala.	McClelland	Maj. L. C. Dulin	John O. Chisholm & Co.
30	Greenville, S. C.	Sevier	Maj. A. G. Doyle	Gallavan Building Co., Greenville, S.C.
31	Macon, Ga.	Wheeler	Maj. Walter Hernwood	W. Z. Williams, Macon, Ga.
32	Waco, Tex.	MacArthur	Maj. Matthew Hanson	Fred A. Jones Construction Co., Dallas, Tex.
33	Houston, Tex.	Logan	Capt. W. P. Rothrock	American Construction Co., Houston, Tex.
34	Deming, N. M.	Cody	Maj. Charles H. Miller	J. W. Thompson Co., St. Louis, Mo.
35	Fort Sill, Okla.	Doniphan	Maj. George D. Guyer	Selden Breck Construction Co., St. Louis, Mo.
36	Fort Worth, Tex.	Bowie	Maj. P. J. Vanzuben	J. W. Thompson, Dallas, Tex.
37	Montgomery, Ala.	Sheridan	Maj. A. W. Reynolds	Algernon Blair, Montgomery, Ala.
38	Hattiesburg, Miss.	Shelby	Maj. W. J Howard	T. S. Moody & Co., Chattanooga, Tenn.
39	Alexandria, La.	Beauregard	Maj. W. R. Goss	Stewart McGhee Construction Co., Little Rock, Ark.
40	Linda Vista, Calif.	Kearney	First Lieut. Charles Rogers	W. E. Hampton Co., Los Angeles, Cal.
41	Palto Alto, Calif.	Fremont		The Lindgren Co., San Francisco, Cal.

Railroads Are Meeting Extra War Burden

Report of Chairman Harrison Shows Advantages of Joint Operation by Railroad Men

The Railroads' War Board issued a review on Aug. 5 of the work it has accomplished in the war operation of the carriers of the United States as one continental system, in which it was shown that with practically no increase in equipment the roads were doing 16.1% more work than under individual operation.

In a statement signed by Fairfax Harrison, president of the Southern Ry. and chairman of the war board, it was said that the success of the war operation of the railroads by railroad men to give the maximum of transportation service, irrespective of the welfare of any particular road or roads, could no longer be doubted.

First Month's Figures Show Increase

The first meeting of the war board was held Apr. 23. Figures for May, the first full month following, show that the railroads rendered about 16% more freight service with practically the same number of cars and locomotives as last year.

Actual returns just now compiled are from railroads having 173,105 miles of line. The reports show that these lines in May last year gave service equivalent to carrying 25,426,845,011 tons of freight one mile, while this year they carried 29,522,870,109 tons one mile, an increase of exactly 16.1%. This great increase in service was rendered with a very slight increase in the amount of equipment used. The number of freight locomotives in service in May last year was 24,362, while this year the number was 24,483, an increase of one-half of 1 per cent.

Last year in May there were 1,800,842 freight cars in service, while this year the number was 1,833,921, an increase of 1⅞ per cent.

Repairs Are Speeded Up

A distinct mark of progress is the great reduction in the number of freight cars in the shop or awaiting repairs. Last year in May there were 114,147 cars under or awaiting repairs, while this year only 104,061 were in that condition. Locomotives in repair or awaiting repairs last year were 4006, and in May this year 3593, a reduction of 10.3 per cent.

Last year railroad locomotives ran an average of 65.5 miles per day, while this year they made 71.3 miles. Freight cars made an average of 28.3 miles a day in May last year, and this year 29.6 miles, an increase of 5%. In the same period, the mileage of cars moving empty was reduced by 5%, while the mileage of cars moving under load was increased by 9.5%. The foregoing figures will appear all the more remarkable when it is realized that May, 1916, was itself a month of heavy traffic.

Dominion To Take Over Canadian Northern Railway

Plans of the Canadian Government for acquiring the Canadian Northern Ry., with its 9000 miles of line, were announced in Parliament last week by Sir Thomas White. The Canadian Northern is one of the systems that has received a large amount of Government aid and is still in financial difficulty, as was pointed out in the recent report of the Royal Commission. The Government already owns $60,000,000 of the $100,000,000 capital stock.

The acquisition of the Canadian Northern would give the Dominion Government, with the Intercolonial Ry., a coast-to-coast line. The Finance Minister states that the Government also contemplates the acquisition of the Grand Trunk Pacific Ry., but is not at present ready to finance the project.

It is understood that the Government favors the retention of many of the present operating heads of the Canadian Northern.

Municipal Work Active in Bismarck, N. D.

One of the largest paving projects ever carried out in one job west of Chicago is under way in Bismarck, N. D. The total amount of the work is $500,000. Of this, $130,000 is in the business part of the city, being bitulithic on 5-in. concrete base, while $370,000 is being expended in the residence district, where sheet asphalt pavement on 5-in. concrete base is being laid. The two sections will be completed by Aug. 10 and Nov. 1 respectively. The Ford Paving Co., of Cedar Rapids, Iowa, has this paving contract.

Incidental to the work of paving, storm-sewer construction to the amount of $70,000 was necessary, and is practically completed at this time. There is also about $7000 worth of sanitary sewer being constructed in the city this season. T. R. Atkinson, of Bismarck, is in charge of the construction.

Far West Wants Road Maps on Smaller Scale

A stipulation of the United States Office of Public and Rural Engineering is that prior to the Government's participation in highway improvement, maps of all proposed routes shall be made on a scale of 1 in.-1 mile. It is claimed that this condition imposes an unnecessary hardship in map making in the case of desert roads in states of "magnificent distances." Under this condition the improvement of a little stretch of 50 miles would call for a great deal of tracing cloth to designate a pair of parallel lines. It is expected that a concession will be made in favor of smaller scale maps, or a more definite ruling made as to whether improvements of the kind contemplated constitute the "permanent highway improvement" required as the prime requisite for Federal aid.

Contract Soon To Be Let for New Lower Otay Dam

Foundations Found To Be Satisfactory for Gravity Type Dam To Replace One Destroyed

Test borings and detailed examinations of the foundations at the site of the lower Otay dam, near San Diego, Calif., are being made for the city as a preliminary to letting the contract for a gravity type concrete dam to replace the one which was destroyed by flood last year. Complete details of the accident appeared in the *Engineering Record* of Feb. 12, 1916, and in *Engineering News* of Feb. 17, 1916.

The foundations have been found to be satisfactory, the details of the new structure have been decided upon and bids are to be called for as soon as the bonds are sold. The new dam will involve about 30,000 cu.yd. of excavation —about one-third in rock—the placing of 75,000 cu.yd. of concrete and 20,000 cu.yd. of mass rock. Some grouting of foundation may also be required as well as 2000 cu.yd. of concrete in the separate spillway, which will require some 6000 cu.yd. additional excavation.

The work is located about 20 miles southeast of San Diego and about 10 miles from the industrial track of the San Diego & Arizona Ry. H. N. Savage, hydraulic engineer for the City of San Diego, is directing the preliminary work at the site.

Committee Will Register Engineers for Engineering Council

A committee has been appointed by the Engineering Council to get up a register of engineers and work has started actively. The committee originally had four members, one from each of the founder societies of the Engineering Council. It has instructions "to collect information regarding the special qualifications of the members of the four societies to perform the various kinds of engineering service." The committee was also given authority to invite other societies to coöperate in its activity. As at present constituted, the committee consists of George J. Foran, Alfred D. Flinn, A. S. McAllister, E. B. Sturgess and G. C. Stone.

A list of all available engineering addresses is now being prepared by the committee, made up from membership lists of technical and semi-technical societies and other sources. An eight-page blank form has been prepared to be sent out to all names on the list. The answers to this form will constitute a very thorough biographical record of engineers, and from this special groupings will be made according to different kinds of service.

It is intended to make the list available to the Government, to enable the department to select engineers for special service that may be needed. The permanent use of the list, however, will be wholly for purposes of the Engineering Council.

States Adopt Uniform Boi ler Law

The American Uniform Boiler Law Society, organized to secure the legal adoption of the boiler code of the American Society of Mechanical Engineers, reports, under recent date, that the work it has accomplished promises to be very far reaching in its results. The main efforts have been turned toward having the various legislatures pass enabling acts creating boards to draw rules, feeling that if this were accomplished the inherent value and balance of the American Society code would make its adoption an assured fact. While there were several states which failed to pass the necessary legislation, the committee feels quite confident that but little opposition will be encountered next time.

Unexpected opposition was met with from the Boilermakers' Union, which, under the leadership of James J. Casey, succeeded in several cases in having a rider attached to the enabling act, which provided that only boilermakers should be appointed as inspectors. Generally this rider succeeded in defeating the law. The society has remained steadfastly single in its aims and has not attempted to limit in any way the manner in which the code should be applied or who should have jurisdiction over it—feeling that these are matters which must be settled in the various states according to conditions.

The states and cities in which the code has been adopted, or is in process of adoption, are as follows: New York, New Jersey, Pennsylvania, Ohio, California, Minnesota, Wisconsin, Michigan and Indiana, and the cities of St. Louis and Kansas City, Mo. The bill was introduced in the following states, where it has failed of passage due to various reasons: Washington, Oregon, Texas, Tennessee, Rhode Island, New Hampshire, South Dakota, Iowa, Utah and Kansas.

Government Will Investigate Feeding Garbage to Hogs

An investigation of feeding garbage to hogs with a view to utilizing this material to the best advantage in conserving the food supply of the country will be made by the United States Department of Agriculture through the Bureau of Animal Industry, of which Dr. A. D. Melvin is chief. The work has been assigned to the Division of Animal Husbandry, George M. Rommel, chief, and also to George H. Shaw, sanitary engineer of the department. Mr. Rommel will study how to utilize garbage to the best advantage as food for hogs, and Mr. Shaw will take up the sanitary engineering features involved.

Visits will be made to large hog farms where garbage is used, and in addition experiments will be conducted at the Bureau farm at Beltsville, Md. It is expected that such questions will be considered as methods of garbage collection from houses, the sanitary handling of garbage, heat treatment of garbage before feeding, layout of feeding plants, various garbage-feeding data and the financial side of the problem.

The department will be glad to receive from sanitary engineers, city officials and others interested in garbage disposal any available data bearing upon the general subject under investigation. It is likely that a department publication covering the results of the investigation will be issued.

New Railroad Shops for Southern Pacific at San Francisco

Railroad repair and freight-switching yards are being built by the Southern Pacific company at a new location in Visitacion Valley, on the southern boundary of San Francisco. The company owns a 260-acre tract there, and extensive improvements are now well along toward completion. Two large steel-frame shop buildings have been completed, a third building of the same type is nearing completion, and a 17-stall roundhouse, power plant and 20 miles of track are already finished. Among the other improvements are a freight-car repair shop, 118 x 140 ft. in plan; 185 x 335-ft. planing mill and car shop; 130 x 346-ft. machine shop; and a 52 x 103-ft. store building. The work is expected to be completed and the yard in operation by the end of the year.

An independent organization of San Francisco citizens is planning the construction of a model workingmen's town on a newly laid out townsite adjoining the shops. Here, conveniently located, attractive homes in good surroundings are to be leased or sold on terms within reach of the workingman.

Pit River Power To Be Available Within Five Years

The Pacific Gas and Electric Co. has announced that it will at once take over the construction work on the Big Bend project on Pit River, developing the rights recently secured from the Mt. Shasta Power Corporation. The power house site is about 60 miles northeast of Redding and is served by drainage basins of 4385 square miles from which the minimum flow is about 2400 sec.-ft. The head utilized will be about 940 ft. and at minimum flow it is expected that 180,000 hp. will be developed. The installed capacity is to be 200,000 kw.

The construction required involves a diversion dam which will divert the stream into a 7-mile conduit, of which 6 miles will be in tunnel and 1 mile in reinforced-concrete pipe. The tunnel is to have a grade of 1 in 1000 and will be kept under a head of about 50 ft. Small storage capacity sufficient for daily load fluctuations, will be provided in the fore-bay.

The construction schedule as at present laid out calls for expenditures on the following basis: First year, $300,000; second year, $1,500,000; third year, $2,000,000; fourth year, $7,000,000; fifth year, $6,700,000, making a total expenditure of $17,500,000 distributed over a five-year construction period. The purchase of water wheels and generators is to be left until the last, so as to take advantage of such improvements in design as may take place meantime.

The work this year is to be a continuation of the two exploration tunnels begun by the Mt. Shasta company. These tunnels are now 7 x 7 ft. in section. From now on these will probably be advanced as the top headings for a larger bore. A tunnel 20 ft. in diameter is to be the size for supplying the plant now proposed. The voltage of the transmission line to connect with the company's system has not yet been decided upon but will not be less, it is announced, than 110,000 volts. A recent report of the State Water Commission estimates a total of 412,000 hp. available on the Pit River without storage.

Ohio Engineering Society Proposes Uniform Fees

The schedule for engineers' fees that is in force in Mahoning and Trumbull Counties, Ohio, has been sent to the various engineers of that state as one which has met with success and is worthy of being followed. The per diem rate of $25 a day is the base charge for consultation, opinion, testimony, preliminary investigation, report and consulting capacity upon design. In addition to this figure, sums are named for special kinds of services from rodman and chainman up to engineering and supervision for sewer districts.

Chooses Heavier Concrete Base

The Kansas City Board of Public Works, acting on the recommendation of Curtis Hill, city engineer, refused the petition to reduce the thickness of concrete base under pavements from 8 in. to 7 in. Mr. Hill feels that the recommendation should be rather to increase the depth of the base, because the specifications now in use did not anticipate the heavy tonnage of motor trucks under which pavement bases have been breaking down and the life of the pavements materially shortened—the saving of a few cents in the original cost hardly being balanced by considerations of final economy.

Septic Tank Conference

A conference of the National Septic Process League has been called to meet at the La Salle Hotel, Chicago, Aug. 14, at 10 a.m. One of the objects of the conference is to consider a proposition made to the officers of the league by the Cameron Septic Tank Co. to settle its claims against members of the league at a reduction of at least 25% of the regular royalties charged. Nonmembers of the league, threatened with suits for septic tank patent royalties, are invited to attend. Frank G. Pierce, Marshalltown, Iowa, is secretary of the National Septic Tank Process Protective League.

PERSONAL NOTES

M. P. PARET, formerly district engineer with the Interstate Commerce Commission, has opened an office as consulting enginer at Lake Charles, Louisiana.

G. MURRELL MIDDLETON has resigned as road engineer of Shelby County, Kentucky, to take effect Nov. 1.

THOMAS A. HAMILTON, who has for the past four years been connected with the Crane Co., is now representing the Walter A. Zelnicker Supply Co., St. Louis, in the Birmingham district, with headquarters in the Woodward Building, Birmingham.

WILLIAM SMITH has succeeded HENRY DENNEN as city engineer at Jackson, Ky. Mr. Dennen's resignation was due to failing health.

FRED TATE, formerly resident engineer for the Smith Building Co., Norton, Va., has resigned to accept similar work in Bluefield, Kentucky.

GEORGE WELLS has been appointed chief engineer of highways of Pike County, Kentucky, with headquarters at Pikesville.

WILLIAM FORRESTER, Nashville, Tenn., has become chief engineer for the Mayking Coal Corporation at Mayking, Ky. Mr. Forrester was formerly connected with the city engineering department of Nashville, Kentucky.

R. C. ROBINSON has been appointed resident engineer for the Michigan Central R.R., in charge of the field work connected with the boring for examination of foundations for a bridge at Niagara Falls.

W. F. GREENE has been appointed division engineer of the Monongahela Division of the Pennsylvania R.R., with headquarters at Pittsburgh, Penn., succeeding P. J. SKILLMAN, transferred.

F. B. TAPLEY, assistant engineer of the Canadian Government Railways at Moncton, N. B., has been appointed assistant engineer of maintenance, all lines, and will report to the chief enginer.

J. F. DEIMLING, assistant chief engineer of the Michigan Central R.R., has been appointed acting chief engineer, vice G. H. WEBB, who has been commissioned lieutenant colonel in the Sixth Engineers, National Army.

ROGER TAYLOR has been promoted to assistant general superintendent of the Northern Pacific R.R., with headquarters in Helena, Montana.

A. B. WOOD, mechanical and electrical engineer of the New Orleans Water and Sewage Commission, has been retained as consulting engineer by the Sanitary District of Chicago on the design and construction of the 1000-sec.-ft. Calumet and other pumping plants under consideration. He will still retain his position in New Orleans.

F. F. LONGLEY, a member of the firm of Hazen & Whipple, consulting civil engineers, New York City, has been commissioned as major and has been sent to France to assume entire charge of water-supply for the American expeditionary forces. Graduated from the United States Military Academy in 1902, Mr. Longley was commissioned in the Corps of Engineers, but soon afterward resigned, working from 1902 to 1903 under Joseph H. Wallace, on the construction of a paper mill, and then under George S. Pierson, of Kalamazoo, Mich., in charge of design and construction of sewage systems and disposal plants, and of the construction of a concrete steel weir at Rome City, Ind. At various times in the following few years he had charge of test runs of mechanical filter plants at Moline, Ill., of the operation of the Watertown mechanical filter plant, and of the Washington, D. C., filtration plant, making a report on the preliminary treatment of the Potomac River water. In 1908 and 1909 he had charge of investigations, surveys and preliminary design for increasing the water-supply of Washington, D. C., and from this latter date to 1912 he was in charge of construction of the sand filter plant for Toronto. In 1912 he became a member of the firm of Hazen & Whipple and had in charge various sanitary engineering problems, including design of additional filters for Toronto, investigations and design of work for increase of water-supply of Salem and Beverly, and investigations connected with the treatment of the Catskill water-supply for the City of New York.

Goes to France To Assume Charge of Army's Water-Supply

MAJ. F. F. LONGLEY

PROF. CHARLES J. BARTLETT, director of the Pathological Laboratory at Yale University, has been appointed director of the Bureau of Laboratories, Connecticut State Department of Health.

W. L. SACKETT has been appointed superintendent of waterways of the Department of Public Works and Buildings, State of Illinois, succeeding R. F. BURT, who remains temporarily at the head of the office.

J. H. PRIOR, formerly chief engineer, Illinois Public Utilities Commission, has left the service of the commission to open an office as consulting engineer in Chicago.

W. D. SHANNON, who has been superintendent of construction for Stone & Webster on the work of installing a new unit at the White River station of the Puget Sound Traction, Light and Power Co., Seattle, Wash., is at present in Youngstown, Ohio, where he is engaged as superintendent on the construction of an industrial city for the Carnegie Steel Co. This work is being done by Stone & Webster and consists of the installation of water-works, sewers, pavements and sidewalks and the construction of approximately 250 houses of various types. The new city is located near Girard, Ohio, and adjacent to the new mills being erected by the Carnegie Steel Company.

H. E. REEDER, formerly with the Southern California Edison Co., of Los Angeles, Calif., has accepted the position of construction engineer for the U. S. Smelting, Refining and Mining Co., of Pachuca, Hildago, Mexico.

CARL H. REEVES, consulting engineer and secretary-treasurer of the Seattle Association of Members of the American Society of Civil Engineers, who was recently appointed captain in the Officers' Reserve Corps, has been appointed superintendent of construction at the National Guard cantonment at Palo Alto, California.

WILLIAM B. HOKE, who has served as assistant to the engineer, Water-Supply Commission of Pennsylvania, and assistant engineer, Board of Water-Supply, City of New York, has accepted a position as field engineer for Mason & Hanger Co. on the erection of the United States Army cantonments at Louisville, Kentucky.

LEROY K. SHERMAN, for three years engineer member of the Illinois State River and Lake Commission, has taken up private practice as a consulting engineer and has opened offices at 137 South La Salle St., Chicago, Ill., making a specialty of hydraulic engineering, land drainage and sewage disposal and public-utility organization and appraisal. Mr. Sherman was at one time assistant chief engineer of the Sanitary District of Chicago, having charge of the construction of the controlling works and hydro-electric plant at Lockport, Illinois.

CAPT. PAUL HANSEN, Engineer Officers' Reserve Corps, and formerly chief sanitary engineer of the Illinois State Board of Health, has been

ordered to service with the United States forces in France.

HENRY D. LINDSLEY and THOMAS T. DESMOND announce the organization of their business as investment bankers and engineers under the name of Lindsley, Desmond & Co., with offices at 31 Nassau St., New York City.

E. H. BARNHARD, division engineer, maintenance-of-way, of the Baltimore & Ohio R.R. at Wheeling, W. Va., has been transferred to Baltimore, Md., succeeding RICHARD BROOKE, who resigned to enter military service. P. A. BEATTY, assistant engineer at Baltimore, has been promoted to division engineer, maintenance-of-way, with headquarters at Wheeling, succeeding Mr. Barnhard.

HOWARD ELLIOTT, formerly president of the New York, New Haven & Hartford R.R., has been elected chairman of the Executive Committee of the Northern Pacific Ry., with headquarters in New York. Mr. Elliott has been a member of this committee since July 1 and retains his connection with the New Haven road as chairman of a committee in charge of intercorporate affairs. He will also continue as a member of the Railroads' War Board.

S. J. WILLIAMS, formerly of Milwaukee, state building inspector under the Wisconsin State Industrial Commission, has been promoted to the position of engineer-in-charge of safety and sanitation of the Industrial Commission. This department includes factory, building and boiler inspection and fire prevention.

C. H. BYERS has been apointed district engineer and W. H. DAVISSON has been appointed assistant district engineer in the office of the Pacific District, Division of Valuation, Interstate Commerce Commission, with offices at San Francisco. These appointments were effective Aug. 1.

OBITUARY

HENRY NEWTON RANDALL, general contractor, of Portland, Ore., was killed recently in Battle Creek, Mich., by a Michigan Central passenger train. For the past ten years Mr. Randall had been connected with the Porter Bros. Co., general contractors, of Portland and Spokane, and was engaged at the time of his death in a subcontract from this firm on the Battle Creek cantonment.

D. W. SPENCE, dean of engineering and professor of civil engineering at the Agricultural and Mechanical College of Texas, died at Galveston, June 28. Born at Austin, Tex., in 1868, Professor Spence graduated from the University of Texas in 1889, attaining a C. E. degree at the University of Michigan in 1890. For the year after graduation he was engaged in bridge construction in Colorado, and during the next year was chief draftsman for the South Halsted Street Iron Works, Chicago. In 1890 he was appointed assistant professor of civil engineering, physics and drawings at the Agricultural and Mechanical College of Texas, and in 1899 he became professor of physics. In 1903 he was made associate professor of civil engineering, in 1909 professor of structural engineering, and in 1913 dean of engineering and professor of civil engineering.

Engineer Officers' Reserve Corps Assignments

The following-named officers of the Engineer Officers' Reserve Corps are relieved from their obligations in connection with their enlistments at the places indicated below and are assigned to active duty at the same places:

At Vancouver Barracks, Wash.—First Lieut. James O. Jensen.

In the vicinity of Washington, D. C.—Capts. Joseph V. Birch, Dana Q. McComb, Charles R. Humphreys, William H. Messenger, Vinton D. Cockey and Merwin Armstrong; First Lieuts. George H. Morgan, William H. Smith, Samuel A. Graham, Harry W. Hill, Matthew J. Hoff, Francis H. Kingsbury, Lester C. Smith, Robert Lloyd, Henry C. McRae, Raymond C. Semple, Francis H. Wisewell, Jr., Philip B. Hoge, Hobert W. French, J. Milnor Roberts, David A. Gilbert, Walter R. Morse, Archibald S. Wilson, Donald B. Adams, Henry W. Clark, Fred C. McFarland and Frank L. Weaver; Second Lieuts. Fred G. Rockwell, William A. Bassett, William G. Perry, Charles E. Bretz, Frank E. Edebohls, John C. Metzger, George L. Winslow, James P. Woodson, Daniel C. Kane, Bewley E. Merrell and Walter F. Flynn.

At Fort Leavenworth, Kan.—Capts. Eugene N. Sanctuary, Carroll R. Forbes, Hill P. Wilson, Jr., Edgar S. McCandliss, Dickens S. Adams, Arthur J. Rife, James R. Fuller, Albert Smith, Clarence E. Russell, Thomas H. Holmes and Philip J. Watson, Jr.; First Lieuts. George A. Anderson, Harry B. Kircher, Albert R. Montague, Walter G. Gruber, Ridgely C. Lilly, Ilo I. Taylor, Francis S. Lehmann, Clarence N. Bott, Henry C. Bryan, Albert Gonsior, William S. Etheridge, Ralph D. Salisbury, Edwin M. Sincere, Henry S. Gove, Earle W. Jennings, Edwin B. Styles, Alexander M. Thompson, Robert L. Fitzgerald, Philip R. Elfstrom, L. Garland Lyman, Edward P. Alexander and Charles Sacra; Second Lieuts. Charles R. Wood, Albert O. Ayers, Orville T. Beadle, Willard E. Lofgren, William J. Brush, Thomas A. Mottram, William W. Zass, Jr., Scott B. Christopher, Barton D. Wood, Otto L. Robinson, Fred R. Beerman, Hamlet P. Jones, Fred A. Rohn, William H. Dial, Lloyd Heulings, Joseph A. Noble, Ralph E. Dickie, Leo J. Dillon, Peter K. Lutken, George R. Mitten, Alvin E. Scott, Dean P. Woleben, Robert S. Meston, Arthur H. Besse, Luther G. Lewis, Charles P. Mottz, Luroy Croy, Edwin A. Kauheimer and Lawrence J. Welch.

The following-named officers of the Engineer Officers' Reserve Corps are relieved from their obligations in connection with their enlistments at the engineer training camps named below and assigned to active duty at the same camps:

At Vancouver Barracks, Wash.—First Lieuts. Clifford E. Chase, Lester O. Wolcott and Benjamin B. Bessesen.

Second Lieuts. Gordon C. Hess and George E. Sperbeck.

In the vicinity of Washington, D. C.—Capts. Richard W. Reading, Cambridge U. Trott, Hugh J. Betterley, George J. F. Carey, William T. Gould, Alexander Colt and Hobart B. Baird.

First Lieuts. Hugh A. Tillett, George M. March, John E. Degan, Frank J. Zapf, Alfred C. George, Homer L. Cappleman, John P. Hallowes, Stewart W. Anderson, Johnson C. Brady, Frederic M. Hartshorne, Lewis H. Hubbard and Thomas B. Kennedy, Jr.

Second Lieuts. Roland G. Stafford, Ray L. Hufford, William E. Bowler, A. Craig Meikle, Lovell L. Turley, Andrew O. Jackson, William Robinson, Clayton E. Swain and Eric W. Luster.

At Fort Leavenworth, Kan.—Capts. Thayer D. Sterling, Alfred P. Poorman, Leon L. Clarke, Leon H. Brady, Alfred C. Whitney, Samuel L. McGlathery, David E. Hannan, Willard A. Knapp, Gary E. Block, Arthur T. Kennedy, Thomas W. Blinn, John J. O'Connor, Lewis D. Rowell, Gustavus A. Loeb, Wilber M. Wilson and Pendleton S. Morris, Jr.

First Lieuts. Carl D. Smith, Ben Gest, Frederick E. Booss, Luther R. Swanson, Thomas J. Summey, William G. Saunders, Lowndes W. Shaw, James Archer Smith, Ralph E. Stevens, James M. Templeton, Benjamin A. Thaxton, Hugh A. Thompson, Charlton C. Whittle, Lester J. Williams, Frank W. Young, Thomas V. Woodring, Herman Fluegel, George K. McCollough, George R. DeBeque, Clarence W. Zachow, Edward H. Taylor, Ernest H. Bailey, Albert B. Jones, Gordon H. Butler, Joseph F. Villavaso, August M. Engel, Richard C. Limerick, Voris R. Norton, Durbin Van Law, Harry G. Burrowes, George B. Farlow, Edward S. Bres, Cassius P. Fletcher and Edgar B. Tolman, Jr.

Second Lieuts. Austin B. Reeve, Royal D. Sundell, James L. Craig, Kenneth Urquhart, Clifford H. Stem, Clarence McK. Rader, Marney B. Willey, Douglas S. Watters, Frank T. Payne, Fred L. Waterman, Merle V. Holmes, Charles K. Elmer, Maurice W. Hewett, Leon L. Savage, Julian W. Alger, Gerhard W. Gunderson, William H. Betts, Joseph W. Anderson, Arthur Hagener, Harold A. Thackrey, Ralph E. Johnston, Daniel R. Crosswell, Swdney A. Mewhirter, Walter E. Higgins and Robert G. Breene.